LABORATORY APPARATUS AND MATERIALS EXHIBITION
PREVIEW NUMBER

LABORATORY PRACTICE

RESEARCH · CONTROL · TEACHING

VOL. 9 No. 6 Published Monthly JUNE 1960

LA 569/85

Potassium Iodide

Interesting Facets

of chemical manufacture include the occurrence, from time to time, of unusual crystal "build-ups". This photograph was taken in one of the many May & Baker laboratories producing chemicals for use throughout the world.

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Items of interest from our laboratory notebooks

▶ Most analysts know about 1:10-phenanthroline and many use it for iron determinations. Not so many people seem to know that **4:7-diphenyl-1:10-phenanthroline** is twice as sensitive as 1:10-phenanthroline in the colorimetric determination of iron. There are several papers on the subject but the latest is *Analyst*, 1958, **83**, 80. The reagent is also called **Bathophenanthroline**, and we make it.

▶ Then again, the substitution of methyl groups in the 2:9 positions has the interesting effect of making the reagent insensitive to iron and we then have a selective and sensitive reagent for copper (see *Anal. Chem.*, 1956, **28**, 1158). Hopkin & Williams make **2:9-dimethyl-1:10-phenanthroline** (sometimes called **Neo-cuproin**).

▶ One does not think of sulphate as a radical one can determine absorptiometrically, but this is now possible for low concentrations. **Barium chloranilate** is the reagent and there are two papers on the subject — *Anal. Chem.*, 1957, **29**, 281 and *Anal. Chem.*, 1958, **30**, 202. Hopkin & Williams make it.

▶ Hopkin & Williams Ltd. were also early off the mark with supplies of the remarkable new colour-producing reagent for fluoride ions, **3-aminomethylalizarin-NN-diacetic acid**, described by Belcher, Leonard and West (*Talanta*, 1959, **2**, 92). This important reagent is already available from stock.

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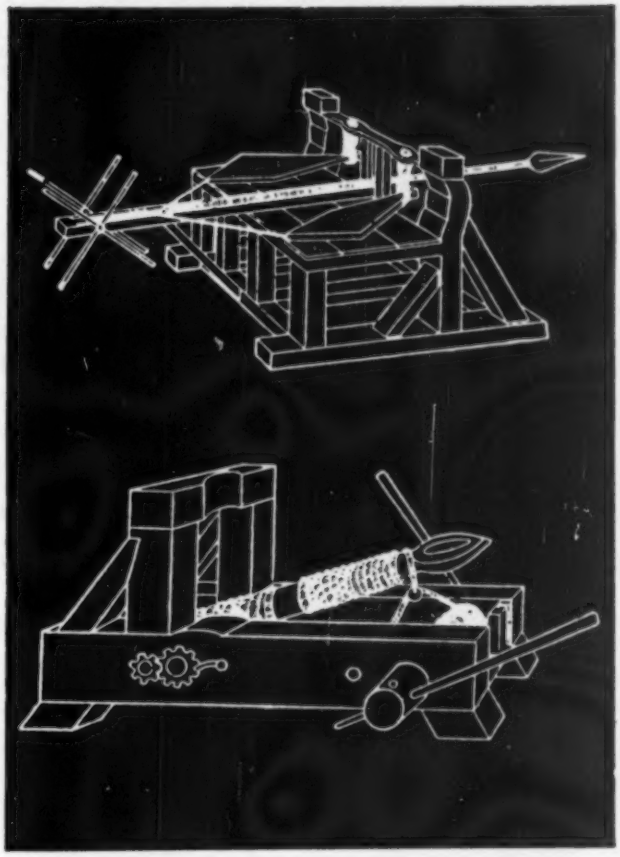

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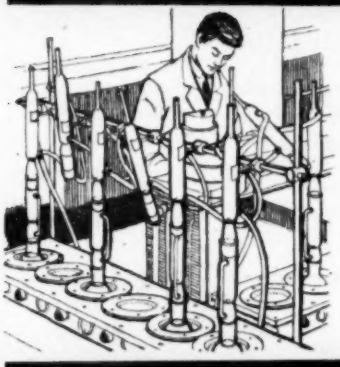

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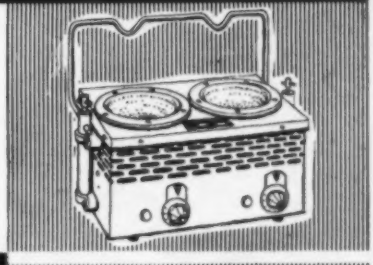

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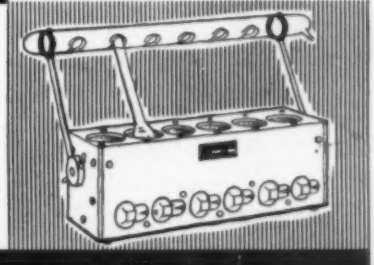

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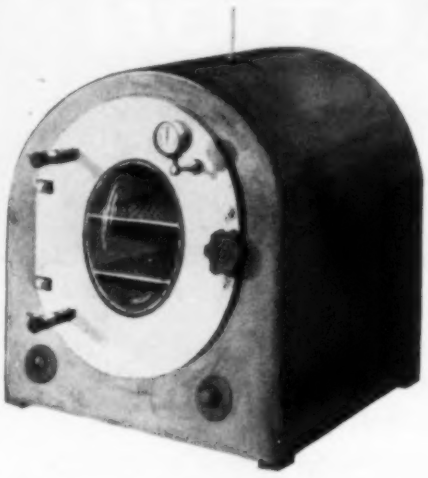

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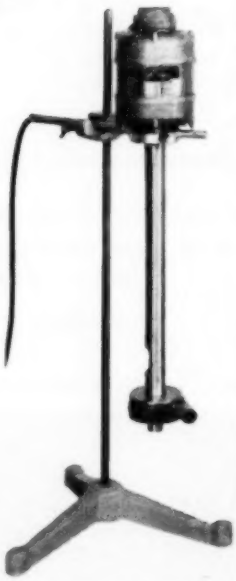

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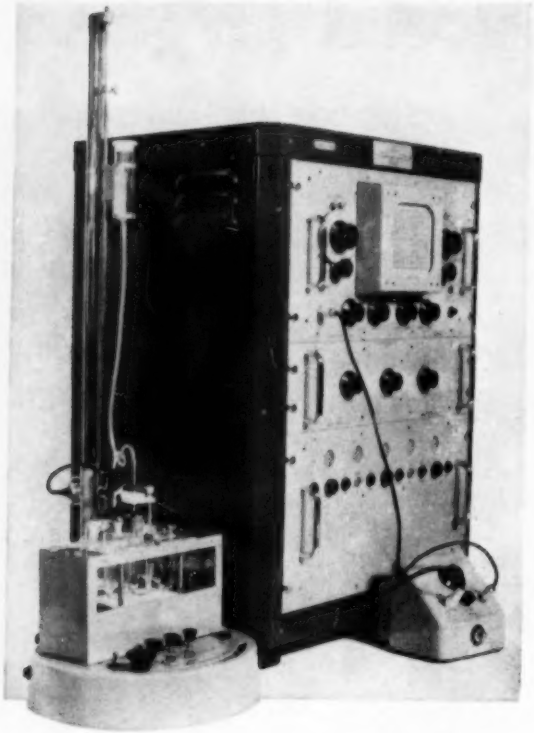

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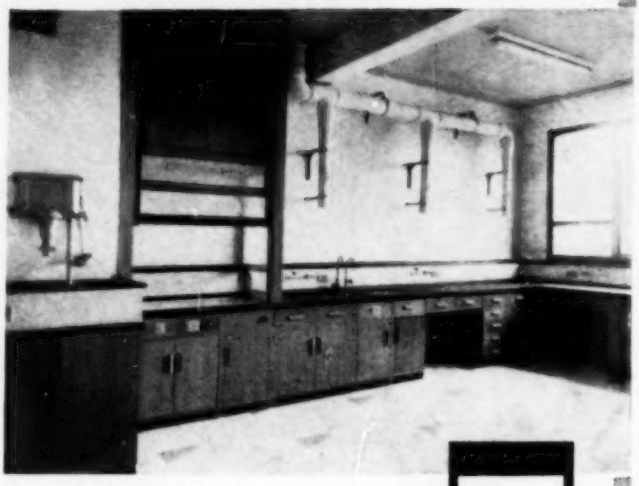

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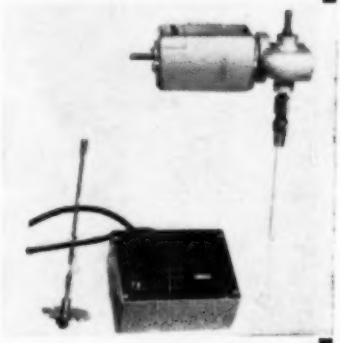

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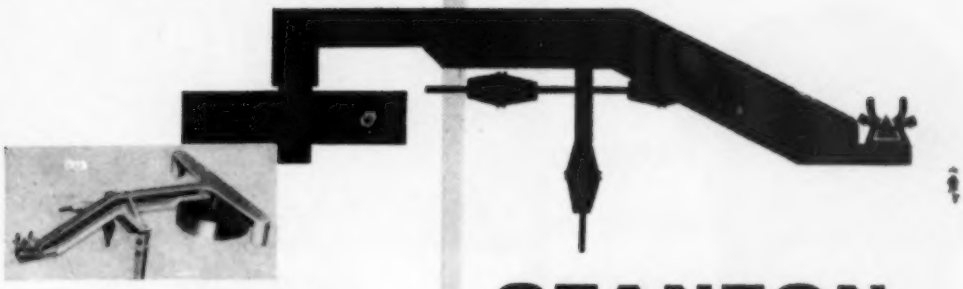

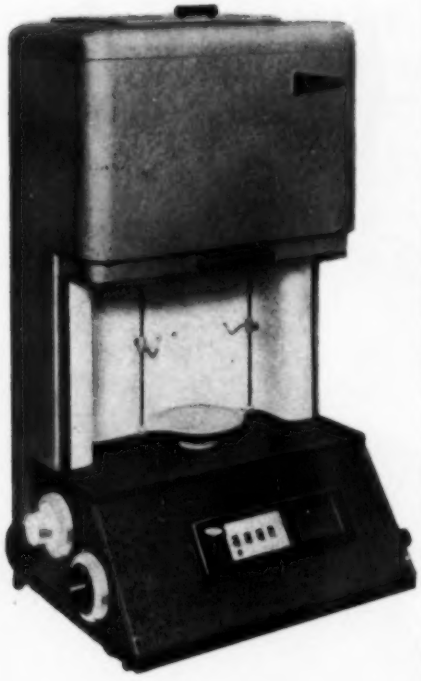

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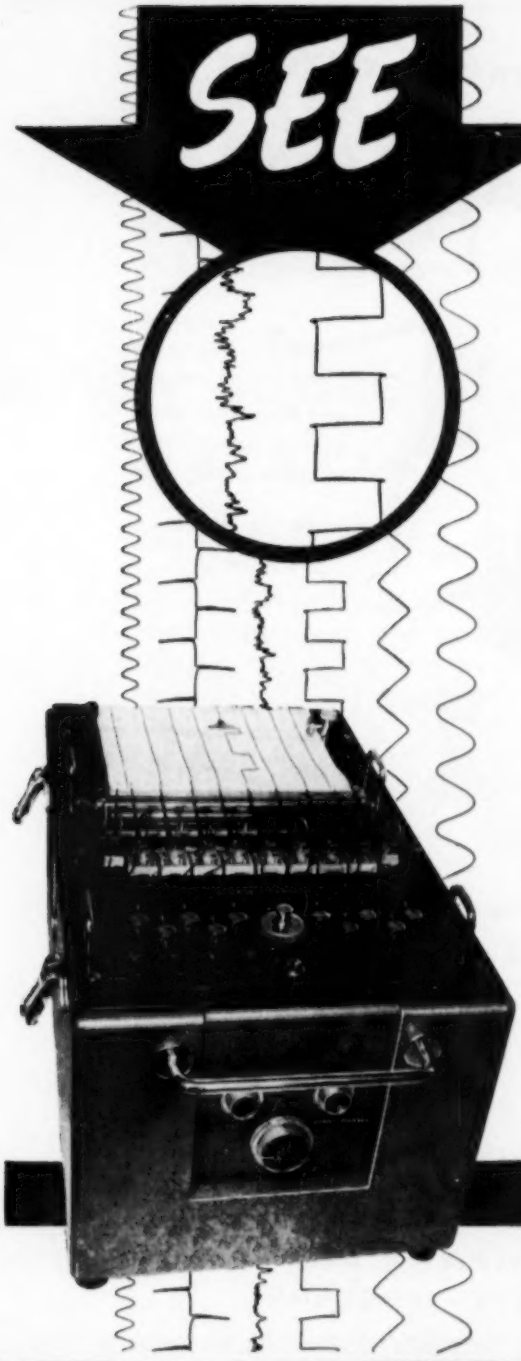

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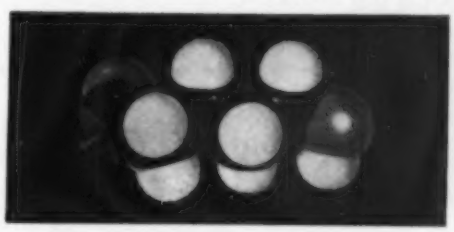

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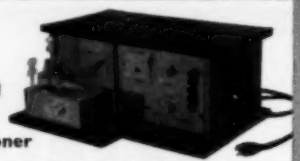

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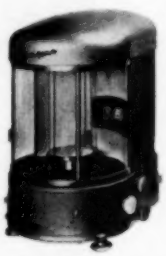

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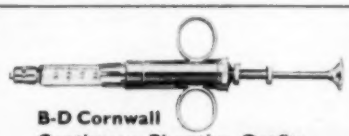

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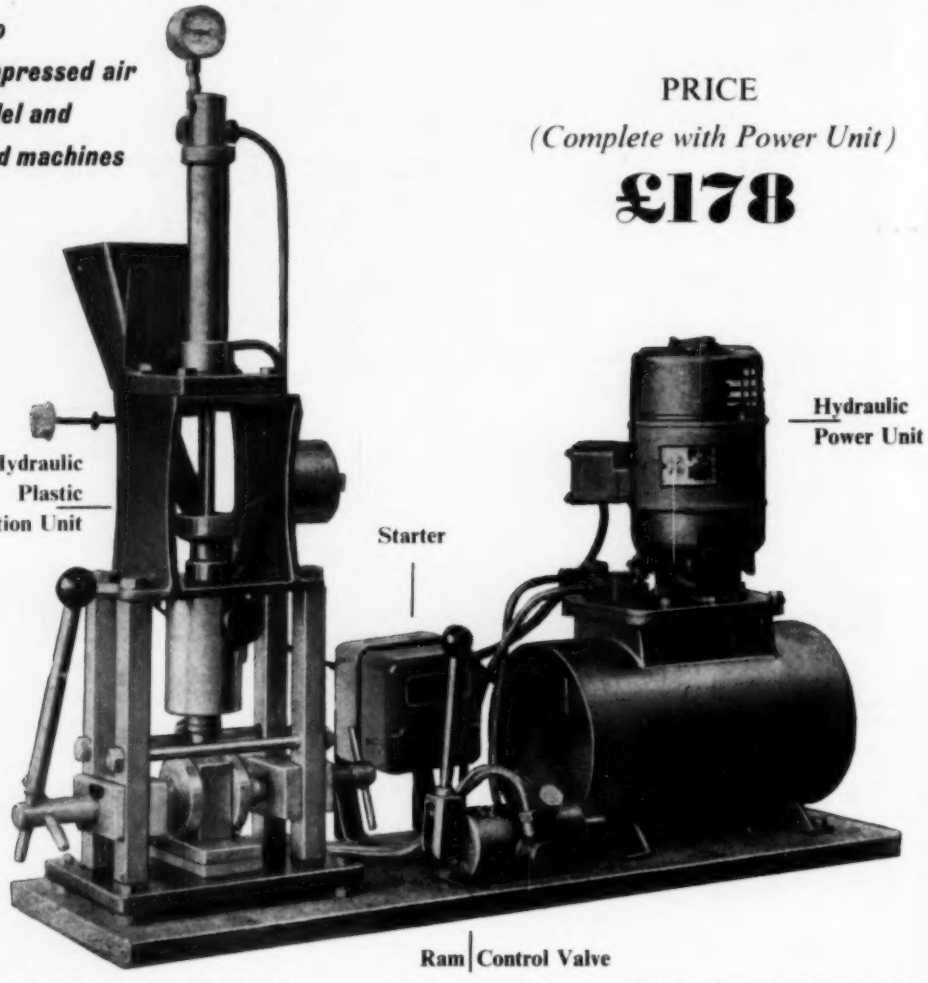

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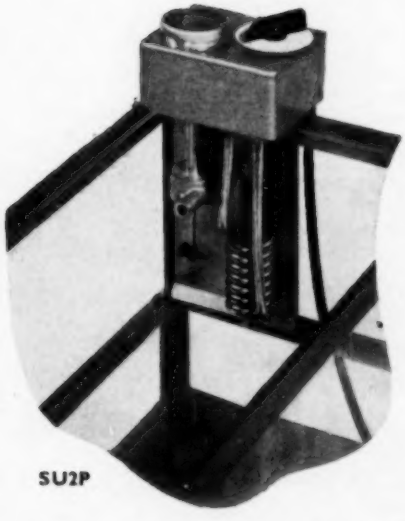

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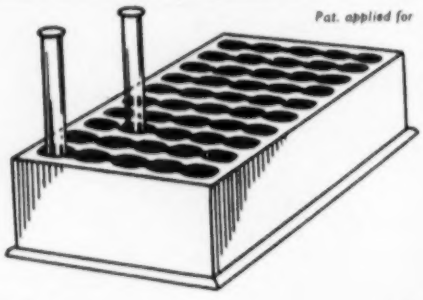

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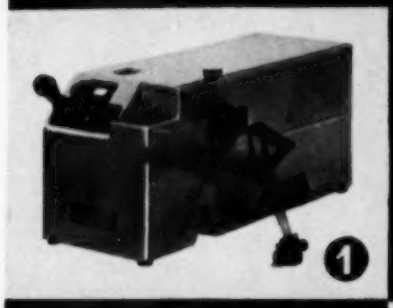

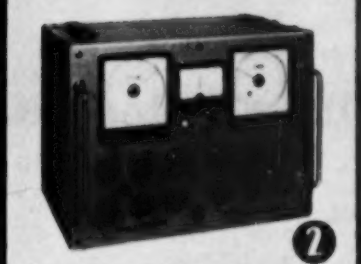

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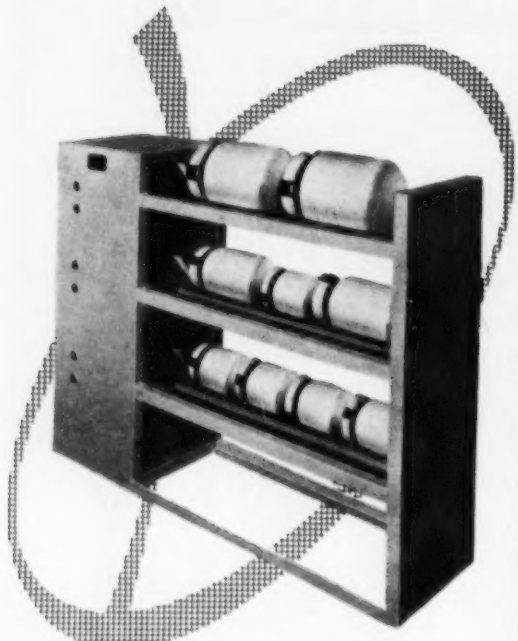

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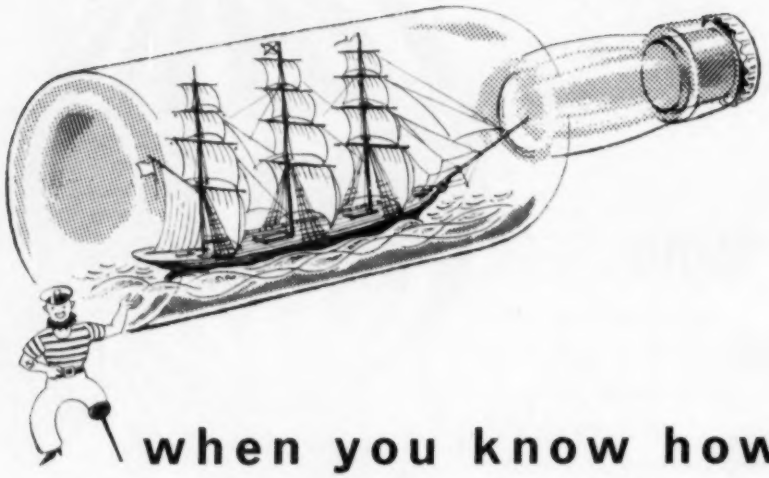

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THE one thing which distinguishes science from nearly all other forms of human thought and progress in knowledge is the experimental approach. Tradition, teaching, personalities, status, attempted political control and many other factors which can influence profoundly the course of other intellectual activities have no standing in science. How often has a beautiful theory been unhappily killed by one unfortunate fact, usually evolved from one rather simple experiment?

Scientific experiment necessarily requires some sort of apparatus, which may be of the simplest kind. The very earliest records, whether pictorial or written, show primitive but efficient equipment, largely concerned with war and food. The earliest of all recorded experiments was concerned with the fruit industry, although whether the experiment can be regarded as successful or not must remain a matter of opinion.

As man evolved he produced better and better tools from wood, bone, ivory, amber and shells and later from flints and finally from metals. Once the basic problems of defence and food storage (by drying, souring, fermentation, salting, etc.) had been solved, man had leisure to turn his attention to the crafts—domestication of animals for food, agriculture, pottery, weaving and ultimately the fashioning of weapons and tools in metal and containers in glass. A fairly advanced technology in some materials had already been evolved by 4000 B.C. and by 2500 B.C. furnaces, balances and other perquisites for metal working were in common use.

As with modern discoveries, some of the greatest were made with quite simple apparatus. According to legend, Archimedes, who first worked out the practical implications of the then existing theoretical knowledge of forces, discovered one of the greatest of physical laws using his own body and a bath. The earliest scientists were obsessed far more by ideas and pure thought than by experiments. Archimedes attached far more importance to his measurement of the value of π (the ratio of the circumference of a circle to its diameter) than to his discoveries of hydraulic screws, burning mirrors, compound pulleys, engines of war and

the other apparatus which have since made him famous.

Perhaps we owe more to Roger Bacon than to any other philosopher the fundamental concept that experiments alone can permit a final judgment in scientific thought. He emphasized that errors arose from an undue regard for authority, habit, prejudice and 'a false conceit of knowledge'. This attitude might well form a text to be exhibited in all laboratories today. As a thinker and experimenter Roger Bacon has been grossly under-estimated. An astronomer of outstanding capacity, he endeavoured to sort the wheat from the chaff by emphasizing the fundamental values of mathematics and optics, quite distinct from the overlying implications of astrology which then tended to swamp all thought on astronomical matters. Bacon understood the laws of reflection and refraction. He described a telescope and discussed the theory of the rainbow. He anticipated mechanically-propelled ships and aeroplanes before 1300.

The scientific work of Leonardo da Vinci has always been overshadowed by his fame as an artist, but he was outstanding experimentally as a physicist, as an engineer and as a biologist. He made great discoveries in anatomy and physiology, anticipating many laws commonly associated with the names of later experimenters.

As we pass through the centuries and review the discoveries of Galileo, Newton, Harvey, Boyle, Galvani, Lavoisier, Dalton, Davey, Faraday, Bunsen, Hertz, Kohlrausch, Van't Hoff and Arrhenius it is possible to see the close relation between apparatus and discovery. Nearly all great discoveries have been associated with elegant techniques and often with quite simple apparatus.

The 20th century has witnessed a new era in science in which a notable feature has been the complexity and expensiveness of the apparatus. Within living memory experimenters have regarded £100 as a lot of money to spend on an apparatus; today research laboratories think nothing of spending thousands, and in some laboratories and pilot-scale units the figures are in the hundreds of thousands.

Science today is characterized by the wealth of apparatus and its complexity and cost. It is therefore all the more important that scientists should have the fullest knowledge of what is available to them. For this purpose a visit to the exhibition at the New Horticultural Hall on June 20-23 can be not only extremely instructive, but also extremely rewarding because money wisely spent is money saved. There is no need to think that only very expensive apparatus will be on view. It is still possible to do good scientific work and even to make discoveries using simple and cheap apparatus. The award of a Nobel prize to Martin and Synge is only one illustration of this generalization. The important thing in buying apparatus is that it shall be suitable for the intended purpose, not that it is the most expensive obtainable. An exhibition affords opportunities to discuss suitability of apparatus not only with the manufacturers but also with other scientists visiting the exhibition. This is by no means a negligible aspect of such a visit.

Recent British Standards

Methods of Testing Vulcanized Rubber, Parts B 11 and B 12 Rubber (Polymer) Preparations (B.S.903: Parts B 11 and B 12:1960)

B.S.903, 'Methods of testing vulcanized rubber' is now in course of revision, and the B.S.I. have just published Parts B 11 and B 12 bound in one volume. B 11 covers the calculation, and B 12 the determination, of rubber (polymer) content. (Price 5s.)

The main difference between these Parts and the previous edition is that the direct determinations have been brought up to date. Also a new method covering the determination of total rubber hydrocarbon (for natural, butadiene-styrene, and butyl rubbers) has been included.

There are detailed descriptions of the reagents required, apparatus, procedure and expression of results. Methods are provided for the following: natural rubber hydrocarbon, nitrogen (for acrylonitrile copolymers), chlorine (for chloroprene polymers and copolymers), and total hydrocarbon rubber (for natural butadiene-styrene and butyl rubbers).

Microchemical Apparatus

Micro-analysts will be interested to learn that the British Standards Institution has published revisions of Parts B2, D3 and H1 of B.S. 1428, 'Microchemical Apparatus'. Synopses of the revised publications are given below.

B.S. 1428:*Part B2*, '*Ammonia distillation apparatus (Markham)*' (price 3s.). In this revised edition the dimensions of the condenser have been brought into line with those specified in B.S. 1848, 'Glass Condensers' and notes on the method of use of the apparatus have been provided for the first time. The amendment of 1956 permitting the use of a spherical ground glass joint between the condenser and distillation vessel is included and the conical joint previously provided for has been omitted.

As in the previous edition, a fully dimensioned diagram is provided, which now shows (and distinguishes) all the mandatory and recommended dimensions.

An appendix lists all the published parts of B.S. 1428, 'Microchemical Apparatus'.

B.S. 1428:*Part D3*, '*Micro-nitrometer (Pregl type)*' (price 4s.). Special features of this revised publication are an increase in the length of the nitrometer and the inclusion of notes on the method of using the apparatus.

The standard specifies the size, material, design and dimensions of the micro-nitrometer, the tolerance on capacity and details of the graduation lines and other inscriptions. A stopcock leakage test is specified in one appendix, and another appendix describes a potassium hydroxide levelling vessel and a porcelain stand suitable for use with the micro-nitrometer.

Fully dimensioned diagrams of the micro-nitrometer and accessory apparatus are included and a final appendix lists all the published parts of B.S. 1428, 'Micro-chemical Apparatus'.

B.S. 1428:*Part H1*, '*Weighing vessels for micro-chemical analysis*' (price 3s.). This revised edition of B.S. 1428:Part H1 contains requirements for two extra sizes of weighing bottles with ground stoppers; the lengths and weights of the weighing pigs and tubes have been reduced. The latter change has not decreased the capacity of the vessels, since ground glass caps are now specified in place of stoppers.

The vessels now specified in the standard are: three weighing bottles with ground stoppers; a weighing pig with ground cap for use with a micro-combustion boat; long-handled weighing tubes with and without ground cap; and a weighing tube with two ground caps for use with hygroscopic substances in the micro-determination of carbon and hydrogen by combustion.

Copies of these Standards may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London W.1

ORIGINAL CONTRIBUTION

THE IDENTIFICATION OF TEEPOL AND SODIUM LAURYL SULPHATE IN A COMMERCIAL DETERGENT MIXTURE

by B. Sewell

THE identification of Teepol, a secondary alkyl alcohol sulphate, and sodium lauryl sulphate, a straight chain fatty alcohol sulphate, has proved rather difficult by available methods of analysis. The following method, which has been tried successfully, involves the hydrolysis of the product and extraction of the mixed alcohols. The 3·5.dinitrobenzoate esters are then prepared and chromatogrammed in benzene, a hydroxylamate staining technique being used.

Method

The detergent mixture, sufficient to give at least 1 g. of the alcohol mixture, is refluxed for 30 min. with about 30 ml. of 3 N hydrochloric acid. Hydrolysis occurs rapidly with alkyl sulphates, but prolonged heating is required for alkyl aryl sulphonates. The mixture is transferred to a separating funnel and extracted three times with 25 ml. of solvent ether. The bulked ether layers are washed well with 10 ml. portions of distilled water until free from acid. The ether solution is then dried thoroughly with anhydrous sodium sulphate, filtered into a beaker and the ether removed on the steam-bath.

About 1 g. of the mixed alcohols is dissolved in 15 ml. of sodium-dried benzene and refluxed gently for two hours with 1·5 g. of 3·5. dinitrobenzoyl chloride and about 5 ml. of redistilled pyridine. After refluxing, the mixture is transferred with 50 ml. of solvent ether to a separating funnel and washed several times with 20 ml. of 6 N. hydrochloric acid, to remove the pyridine. The ether solution is then washed several times with 15 ml. of 4 N sodium hydroxide solution to remove any excess 3·5. dinitrobenzoic acid. The ether solution is then washed free from alkalinity with distilled water, then dried thoroughly with anhydrous sodium sulphate, the solution is filtered into a beaker and the solvent taken off on a steam-bath. The ester is then recrystallized from a mixture of 60-80 petroleum ether and ethyl alcohol.

About 0·05 g. of the recrystallized ester is dissolved in 5 ml. of a 1:1 mixture of dry benzene and acetone and a small amount applied to the baseline of a chromatography paper by means of a capillary tube. The solvent is evaporated and the paper suspended to a depth of about 1 cm. in sodium-dried benzene in an enclosed vessel. The solvent is allowed to ascend to between 15-20 cm. above the baseline before the paper is removed and dried in warm dry air. The paper is then sprayed with a cold saturated alcoholic solution of hydroxylamine hydrochloride and dried in warm air. A cold concentrated alcoholic solution of sodium hydroxide is then sprayed on to the paper which is again dried in warm air.

A yellow band obtained at or near the solvent front indicates the presence of the 3·5. dinitrobenzoate of lauryl or a long chain fatty alcohol; thus indicating sodium lauryl sulphate to be in the original product. A sharp yellow band on or very near the base-line is given by Teepol or a secondary alcohol ester, hence indicating the presence of Teepol in the original product.

There is no mutual effect between the Teepol and lauryl esters affecting band positions.

It has been found that Teepol usually gives a well-defined yellow band near the baseline, but this is usually followed by an even pale yellow background as far as the solvent front. This is possibly due to the impure nature of the Teepol, containing very small quantities of primary alcohol sulphates. This, however, does not interfere with the identification of sodium lauryl sulphate or other primary alcohol sulphates in more than trace quantities in the presence of Teepol.

The presence of an alkyl aryl sulphonate in the original mixture does not interfere in the identification of Teepol and sodium alkyl sulphate as no hydrolysis occurs under the above conditions. If, however, an alkyl aryl sulphonate, for example, sodium dodecyl benzene sulphonate is refluxed with 6 N hydrochloric acid for about two hours and the subsequent procedure applied to the hydrolysis product, then an identical result is obtained to that given by the primary alkyl alcohol sulphate.

Forthcoming Congresses

First International Congress of Histochemistry and Cytochemistry

The First International Congress of Histochemistry and Cytochemistry will be held in Paris from August 28 to September 3. It is organized under the auspices of the Société Française d'Histochimie in collaboration with the histochemical societies in existence all over the world, especially the American Histochemical Society, the Deutsche Arbeitsgemeinschaft für Histochemie, the Société Belge d'Histochimie, the Italian and Japanese histochemical societies and several non-autonomous sections of histochemistry.

At the Congress, many of the most illustrious names of the world's histochemists will be present: Prof. Voss (Germany) who together with the Congress President, Prof. Jean Verne (France) are among the earliest histochemists, their work going back to 1920; Professors Lillie (U.S.A.), Seki (Japan), Vialli (Italy), Lison (Brazil), Brachet (Belgium), Caspersson (Sweden), Asboe-Hansen (Denmark), Danielli and Dr. Pearse (England), all widely known for their fundamental works on histochemistry.

ARTICLES

THE LABORATORY EVALUATION OF GANGLION BLOCKING AGENTS

by J. J. Lewis and T. C. Muir

Experimental Pharmacology, Institute of Physiology, University of Glasgow

PART I

Introduction

The last one hundred years have witnessed such medical and scientific progress that in Britain and other advanced countries man's expectation of life has been greatly increased. This has been achieved through a reduction in the infant mortality rate and by a reduction in the number of deaths from infectious and contagious diseases. The chief causes of death today in Western Europe and North America are cardiovascular diseases and cancer. Although both conditions are predominantly afflictions of older people, they are also responsible for the deaths of a number of the most productive members of society and so have become the two greatest challenges to present-day medical science.

It has been shown by statistical analysis that mortality from cardiovascular disease is related to the arterial blood pressure level and the excess mortality is largely due to cardiovascular and renal disease. High blood pressure or hypertension has become one of the most common diseases and much research into vascular disorders has resulted.

Since the importance of this condition was appreciated, a large number of remedies have been introduced and both surgical and medical procedures have been employed. In present-day practice, although sympathectomy and adrenalectomy are still at times used as methods of treatment for cases of great severity, drug treatment is far more commonly employed. Several classes of drugs have been introduced, among the best known and most effective of which are those blocking nerve impulse transmission in autonomic ganglia, and these compounds are known as ganglion blocking agents. They are used when treatment of the hypertension is considered essential and are reserved for the severe essential and malignant forms of the disease. The use of drugs in milder conditions is a matter for clinical judgment and there is a divergence of opinion among physicians on the advisability of their employment.

Two lines of approach have been used to develop drugs which reduce sympathetic vasoconstrictor tone. These have produced:

(*a*) *Compounds which specifically block nerve impulse transmission at the ganglion synapse.*—Until very recently this approach had produced the most effective compounds. The presence of unwanted parasympathetic ganglion blocking activity in all of the clinically useful drugs has, however, led to a search for compounds with a different mechanism of action.

(*b*) *Specific adrenergic blocking agents.*—These act preferentially on the postganglionic sympathetic nerve fibre endings, i.e. at the neuro-effector junction. This article is concerned only with drugs in group (*a*).

Historical

In 1863 Traube[1] showed that the alkaloid nicotine slowed the dog heart even after vagotomy and that subsequent vagal stimulation no longer caused bradycardia. He concluded that nicotine stimulated and then blocked some connecting link between axons in the nerve trunk and the point of action of atropine which was shown to prevent the nicotine-induced cardiac slowing.

In 1889 Langley[2] showed that the main site of action of nicotine was the autonomic ganglion and that the direct application of this drug to the cat's superior cervical ganglion caused dilatation of the pupil. The same response was induced by electrical stimulation of the cervical sympathetic chain. As application of nicotine to the nerve trunks on either side of the ganglion did not produce this effect. Langley attributed the response to stimulation of the ganglion itself. Langley also showed that, after a time, the initial stimulant effects disappeared and electrical stimulation of the preganglionic fibres of the superior cervical ganglion no longer produced dilation of the pupil, although electrical stimulation of the postganglionic fibres still produced this effect. Langley concluded that nicotine possessed a ganglion stimulant followed by a ganglion blocking action. This discovery led to the use of nicotine as a physiological tool for the purpose of tracing the sympathetic outflow of the various autonomic ganglia. Nicotine is a most valuable substance in the laboratory but it is too toxic for clinical use and in addition causes a very marked stimulation of all autonomic ganglia.

In 1914, Burn and Dale[3] observed that tetraethylammonium chloride (TEA) blocked the passage of impulses through autonomic ganglia without producing an initial phase of stimulation. The 'nicotinic paralysing' action of TEA was later confirmed by Hunt.[4]

Acheson and his colleagues[5,6] in 1946 made a thorough investigation and review of the pharmacological activity of TEA, devoting particular attention to its cardiovascular effects in man. This aroused interest in this class of drug and several new compounds were investigated. The ganglion blocking activity of TEA is however too brief and unselective to permit its use in hypertension. It was however the first drug of this group to be employed clinically in hypertension[7].

Fig. 1.

The management of severe essential and malignant hypertension by drugs is substantially an achievement of the past decade. The compounds which have proved of clinical value are shown in Fig. 1. Most are strong cations and are used in the form of their salts, the strong cationic charge being attributable to one or more quaternary ammonium groups. All block autonomic ganglia and were claimed to have few of the side effects of drugs affecting the autonomic nervous system, *e.g.* adrenergic and muscarinic effects. Nearly all, however, possess considerable parasympathetic as well as sympathetic blocking activity and constipation, postural hypotension and blurred vision are common side effects. The ideal anti-hypertensive drug has yet to be discovered and although the management of hypertension has been achieved with considerable success using available drugs, a compound orally effective and free from parasympathetic blocking activity would be of great value.

The first ganglion blocking agents to be employed successfully in the treatment of hypertension were hexamethonium and pentamethonium, two members of the polymethylene bisquaternary ammonium series first reported by Paton and Zaimis[8] and Barlow and Ing[9] in 1948. Ganglion blockade by these drugs is unselective and unpredictable when they are given orally. They unfortunately possess considerable parasympathetic ganglion blocking activity and cause, for example, dry mouth, blurred vision, impotence and retention of urine. Furthermore, the variable absorption of these drugs after oral administration has been shown to produce irregular effects[10] often necessitating careful individual medical supervision. Freis[11] considered that when a suitable hypotensive dose was obtained intestinal motility was impaired and suggested that continued treatment could lead to prolonged hypotension from accumulation of the drug in the intestinal tract. He also showed that normal bowel motility could be restored by oral treatment with neostigmine. In 1951 Bein and Meier[12] reported the pharmacological activity of azamethonium (Fig. 1) a compound related to hexamethonium and pentamethonium and with similar properties. Wein and Mason[13,14,15] described the activities of another related compound, pentolinium (Fig. 1). Pentolinium resembles hexamethonium pharmacologically and any differences appear to be quantitative rather than qualitative. It possesses some advantages over the other members of this group. It is better absorbed, gives more predictable blood levels, has a longer duration of action and is almost five times as potent as hexamethonium. Hexamethonium, pentamethonium, azamethonium and pentolinium are collectively known as the methonium compounds. Their place has now been largely taken by more effective drugs although pentolinium, the best drug of the group, is still employed in some cases.

The deliberate reduction of blood pressure during surgical operations as opposed to the long term management of hypertension has also been achieved by the use of ganglion blocking agents. From the clinical accounts available it appears that disagreement exists upon the advantages of controlled hypotension in surgery. In 1949 Randall and his colleagues[16] described the pharmacological properties of a new hypotensive drug, trimetaphan camphorsulphonate (Fig. 1). This has been administered as an intravenous infusion to control and stabilize blood pressure levels during surgical procedures. It has also been used in electroconvulsive therapy by Tewfik and Wells[17] to overcome such cardiovascular disturbances as bradycardia, cardiac arrest or hypertension associated with the use of electro-convulsive therapy. Trimetaphan camphorsulphonate has ganglion blocking activity which is very rapid in onset and brief in duration thus differing from hexamethonium and rendering the drug unsuitable for continued administration in the treatment of hypertension. It produces considerable parasympathetic ganglion blockade, liberates histamine and has direct vasodilator activity which is independent of its action on ganglia.

In 1955, Plummer and colleagues[18] reported a new quaternary ammonium ganglion blocking agent chlorisondamine (Fig. 1) claimed to have considerable advantages over existing drugs with a similar mechanism of action. It appears however from subsequent reports that the drug also produces side effects similar to other ganglion blocking agents. Chlorisondamine is more potent than pentolinium and has a longer duration of action, thus offering a wider margin of safety and less likelihood of cumulative effects. It is therefore a useful

addition to the range of drugs available.

The introduction of the secondary amine mecamylamine (Fig. 1) marked a departure from the earlier quaternary ammonium derivatives[19]. This is a very potent long acting drug, claimed to be ninety times as potent as hexamethonium when given orally and with much more predictable effects. Clinically mecamylamine possesses definite advantages over other ganglion blocking drugs. Its most outstanding feature is perhaps its consistent absorption following oral administration; this is probably due to the lack of a charged quaternary ammonium group in the molecule. Mecamylamine in common with other ganglion blocking agents produces the typical side effects associated with the indiscriminate blockade of both sympathetic and parasympathetic ganglia, coupled with effects on the central nervous system.

In 1958 Spinks and Young[20] and Lee and his colleagues[21] described the pharmacological activity of pempidine, a tertiary amine which was reported to be more potent than mecamylamine on the cat's superior cervical ganglion and to have fewer side effects. It has however not supplanted mecamylamine in the treatment of hypertension.

Mode and Site of Action of Drugs Causing Ganglion Blockade

Langley's experiments[2] demonstrated the site and mechanism of action of nicotine. Analogous experiments were carried out using the cat's superior cervical ganglion by Acheson and Periera in 1946[22]. Contractions of the cat's nictitating membrane were induced by electrical stimulation of the preganglionic fibres of the cervical sympathetic trunk and these were decreased or abolished by the intravenous injection of TEA[22]. Postganglionic stimulation of the superior cervical sympathetic trunk during the period of activity of TEA produced normal contractions of the nictitating membrane indicating that the drug did not act on postganglionic nerve fibres. It was also shown that during relaxation of the nictitating membrane action potentials at the site of the preganglionic stimulation were not diminished in that part of the nerve entering the ganglion and it was concluded that nerve impulses reached the ganglion but were not transmitted to the postganglionic axons. Chou and de Elio[23] have shown that TEA reduces or abolishes contractions of the nictitating membrane to acetylcholine injected into the perfused superior cervical ganglion of the dog.

Acheson and Periera[22] also showed that TEA inhibited parasympathetic ganglia by blocking the cardiac effects of vagal stimulation but not of injected acetylcholine, thus further emphasizing the ganglion synapse as the site of action.

Fig. 2 shows the sites of the principal autonomic ganglia together with the main pathways of the autonomic nervous system to the blood vessels and viscera. Acetylcholine is the transmitter released by preganglionic fibres at the ganglion synapse in both

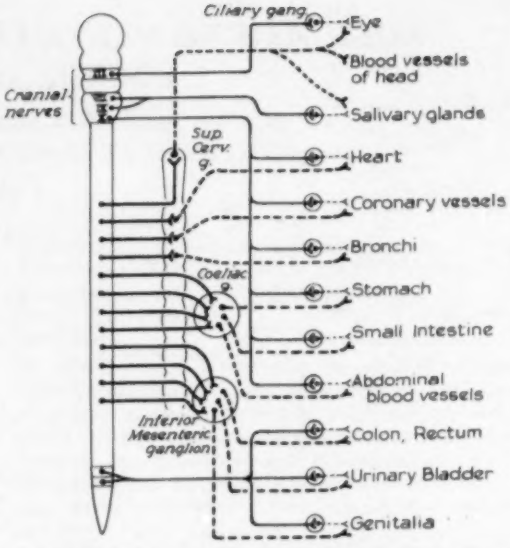


Fig. 2. Principal autonomic ganglia and main pathways of autonomic nervous system to blood vessels and viscera. Thick unbroken lines indicate cholinergic pre-ganglionic nerves. Thick broken lines indicate post-ganglionic adrenergic nerves. Thin broken lines indicate post-ganglionic cholinergic nerves.

cholinergic and adrenergic nerves, and it has been shown by Paton and Perry[24] and Perry and Talesnik[25] that acetylcholine itself can depolarize the superior cervical and ciliary ganglia. Depolarization may persist causing blockade of ganglion transmission by creating a region of electrical inexcitability. Acetylcholine at the ganglion synapse has two main functions. It bridges the gap between the endings of the preganglionic fibres and the dendrites of the postganglionic fibre cell and so initiates impulses in the post-ganglionic axon. In higher doses it can accentuate the process of depolarization to such an extent that transmission is blocked due to persistent depolarization.

Zaimis[26] divided drugs which interfere with ganglion transmission into two categories:

'1. Substances whose chemical structures bear some resemblance to acetylcholine and act by mimicking acetylcholine, competing with or allowing it to accumulate at the ganglion synapse.

'2. Substances whose chemical structures bear little or no resemblance at all to acetylcholine and which probably act on the preganglionic nerve endings or on the effector cells, changing some of the properties essential for normal transmission.'

Only drugs which compete with acetylcholine for receptors in the ganglion cell are suitable for use in hypertension.

Structure—Action Relationships

The difficulty of associating specific structural features

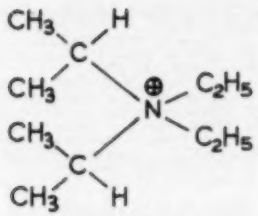


Fig. 3. Diethyldi*iso*propylammonium

with ganglion blocking activity will be readily appreciated. (See Fig. 1). The compounds shown presumably compete with acetylcholine for receptors on the postsynaptic membrane of the ganglion cell, yet the structural requirements for acetylcholine-like activity at the ganglion synapse itself are not fully understood.

Because of their chemical resemblance to acetylcholine, many simple quaternary ammonium compounds related to TEA have been investigated for ganglion blocking activity.[27] From these investigations it appeared that though some compounds were more potent than TEA (for example diethyldiisopropylammonium) none was suitable for clinical use and no definite generalizations regarding structure-action relationships could be drawn (Fig. 3).

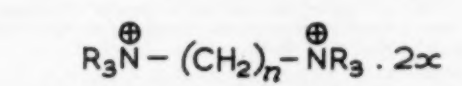
Three members of the polymethylene bisquaternary ammonium series (Fig. 4) have proved of clinical value [30-34]. Of these, two produce ganglion block (hexamethonium and pentamethonium[28,29]) while decamethonium is a potent muscle relaxant[8,9].

In this series, increase or reduction of the number of units in the polymethylene chain joining the quaternary ammonium groups virtually abolishes ganglion blocking activity. This led to the view that in hexamethonium, optimal interonium distance for receptor fit was present. Alteration of the size of the alkyl groups attached to the quaternary ammonium heads showed that substitution of one methyl group by ethyl increased ganglion blocking potency but further replacement caused it to fall off and the triethyl compound had only very weak ganglion blocking activity. It was also shown that the effects of larger alkyl group substitution for methyl on the quaternary nitrogen atoms is to some extent also influenced by the interquaternary chain length. For example the methyldiethylammonium compound is the most active of the tetramethylene derivatives while the ethyldimethylammonium compound is the most potent among the hexamethylene derivatives (Fig. 5).

In the polymethylene bistriethylammonium compounds investigated for ganglion blocking activity by Chou and de Elio[23] only the decamethylene member was more potent than TEA but it also possessed neuromuscular blocking activity.

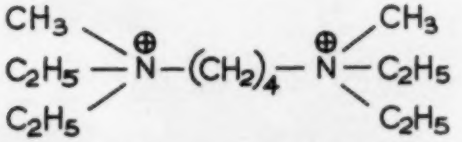
Compounds antagonizing acetylcholine at one site may conceivably antagonize it at another[35] and ganglion blocking activity among atropine-like spasmolytics[36] and antihistamines has been found.[37] For example methanthelinium bromide (Fig. 6) is almost as powerful as TEA in blocking the superior cervical ganglion of the cat but its powerful atropine-like properties render it unsuitable for use in hypertension.[38]

The most potent and most useful drugs have not, however, come from the synthesis of substances which chemically resemble acetylcholine[39]. Neither trimetaphan nor mecamylamine possess a quaternary nitrogen atom and both lack the simple straight aliphatic chain of acetylcholine (Fig. 1) yet both possess strong ganglion blocking activity. Trimetaphan is thirty times more powerful than TEA[16] while mecamylamine is approximately one hundred times more potent than hexamethonium when given orally to man[40]. Chlorisondamine shows a slight structural resemblance to acetylcholine and the methonium compounds in that the molecule contains quaternary nitrogen but with a modified interquaternary polymethylene chain containing a bulky aromatic nucleus. Increase or

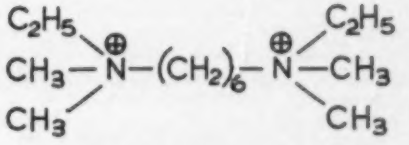


$n = 5$ = pentamethonium
$n = 6$ = hexamethonium
$n = 10$ = decamethonium
$x = Br^{\ominus}$ or $I^{\ominus}$

Fig. 4.



Tetramethylene bis (diethylmethylammonium)



Hexamethylene bis (dimethylethylammonium)

Fig. 5

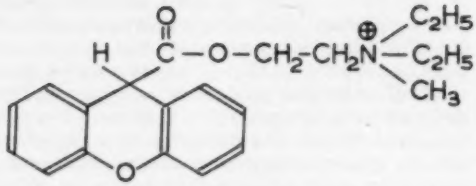


Fig.6. Methanthelinium

decrease in the methylene chain reduces potency as does replacement of methyl by higher alkyl groups on the quaternary nitrogen atoms. The unhalogenated compound has only 1 per cent the activity of chlorisondamine[18].

Configurational differences from acetylcholine in these compounds are obvious and in them no common chemical feature appears to be directly associated with ganglion blocking activity. The experiments of Fakstorp and his colleagues[41-44] on ganglion blocking activity in a series of bischoline ethers have introduced an alternative theory to the classic one of a two point receptor attachment, namely that of a one point ion receptor attachment combined with a less sharply defined adumbration function at the other end of the molecule which provides a screening effect over adjacent areas of the receptor surface. For this one-point attachment, in the compounds investigated by these workers, dimethylethyl or dimethyl-β-hydroxyethyl on the quaternary nitrogen were the preferred groupings. Thus only a comparatively small number of compounds in this series (those possessing the preferred grouping or one closely resembling it) could cause ganglion blockade. The requirements for a satisfactory 'screening' effect are less rigorous and this is of secondary importance in the production of ganglion blockade. It is interesting to note that Wein and his co-workers[45,46] also found that hexamethylene bisdimethylethylammonium was the most potent member of the polymethylene bisquaternary series and also demonstrated that the ganglion blocking potency of a given compound is dependent on such inter-related factors as molecular bulk, interonium chain length and solubility.

(To be continued)

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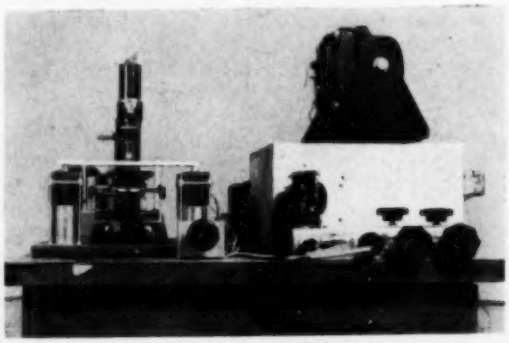
A New 3-D Microscope

A microscope which gives a three-dimensional image or luminous model of the object was shown for the first time on the D.S.I.R. stand at the recent Instruments, Electronics and Automation Exhibition. Designed by a team led by Mr. Richard Gregory at the Cambridge University Psychological Laboratory and supported by a D.S.I.R. grant, it is intended particularly for use in biological research. It should prove useful for examining living cells—perhaps bombarded with radiation for cancer research—and also thick sections of suitably strained brain tissue in order to see how the brain cells are related to each other. Apart from biological applications, the solid image might be a useful way of displaying nuclear tracks in blocks of emulsion for cosmic ray research.

Unlike the conventional stereoscopic microscope, which gives an appearance of depth by providing a slightly different picture to each eye, this new instrument gives a truly solid image projected into a cube of space.

The instrument thus has the important advantage over conventional stereoscopic microscopes that thick sections can be observed in depth.



The 3-D microscope developed at Cambridge University.

THEORY AND PRACTICE IN THE PHYSICAL CHEMISTRY LABORATORY

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Part VII.—SOME ASPECTS OF WATER PURIFICATION

PURE water may be obtained in several ways. These include distillation, ion exchange and electrodialysis. Of these, the first two—and sometimes their combination—are employed in most chemistry laboratories. The third method is yet in its infancy and will therefore not be considered here. The choice of method is sometimes dictated by the degree of purity required, sometimes by economy considerations (which will be considered later) and sometimes by the degree of hardness of the water in the particular district.

The decision as to which process of water purification should be adopted depends mainly on the factor considered more important. However, the likes and dislikes of the person controlling the buying of the water purification plant are sometimes more decisive. The various factors will be contrasted and compared later in this article. At the present stage we shall consider individual processes and allied methods which enhance the attainment of the highest possible efficiency.

Steam which has been employed for the heating of a building is sometimes available for the production of pure water. No doubt a case could be made for tapping such a source of supply and utilizing it in a process of water purification. However, such an arrangement is essentially part of an overall scheme encompassing a large number of laboratories. Here we shall be concerned with the use of individual process units which can be utilized in the average individual chemistry teaching laboratories which accommodate from 15 to 30 students, or in individual industrial chemistry laboratories which accommodate up to 15 chemists.

Let us assume that the supply of water available is that of tap-water. This contains a number of inorganic salts, mainly calcium and magnesium chlorides, sulphates and bicarbonates, as well as minute traces of radioactive strontium. Additionally small quantities of organic substances such as acids and bases and also non-ionizable organic compounds may be present, depending on the original biological population present at some time in the water. Additionally there are present dissolved gases such as carbon dioxide and ammonia, and also suspended dust.

Suspended Matter

Suspended impurities may be removed by passage of the tapwater through a bed consisting of a layer of glass-wool which is placed on top of a deep layer (4 to 5 in.) of pumice. This combination is usually found to be effective, provided the system is renewed once every two weeks. In some laboratories the use of such a preliminary train is omitted without any apparent ill effects on the purity of the water. This obviously depends on the initial state of the tap water.

Distillation

The process of water purification by distillation depends on the principle that when a solution containing non-volatile solids is evaporated, the vapour is solute free and consequently the condensate should also be free from the solid contaminants.

Unfortunately, during the *rapid boiling* which is necessary in the water distillation to ensure a reasonable rate of distilled water supply, the vapour is likely to be contaminated with spray containing some of the dissolved solids. Several anti-splash devices are used to decrease the transfer of such spray to the condensed water. It is, however, necessary to emphasize that for efficient spray removal such units should possess a very large ratio of $\frac{\text{surface area}}{\text{unit volume of vapour}}$ so as to increase the probability of deposition of the liquid spray particles on to the surface. Further, the surfaces of the units must be such as to ensure gravity flow of the liquid back into the distillation chamber. It is not sufficient merely to use a spray deflector method. Tests carried out in this laboratory on simple anti-splash units with comparatively low ratio of $\frac{\text{surface area}}{\text{volume}}$ have shown that their efficiencies leave a great deal to be desired.

Efficient anti-spray systems which are quite complicated may be obtained commercially, or may be made directly. These are usually expensive so far as money or time are concerned. We would advocate, however, that a simpler but nevertheless most effective system be used. This involves a column of glass balls through which the water vapour must pass before it is allowed to condense. The ratio of $\frac{\text{surface area}}{\text{volume}}$ depends on the size of the balls. The smaller the diameter of the balls the greater the above ratio. However, when the inter-ball spaces become very small, the adhering spray tends to block them and the water vapour, as it forces

its way through, becomes re-charged with spray. For this reason it is convenient to use a column made up of a glass tube having a length of about 20 cm. and a diameter of about 5 cm. and containing balls about 1 cm. in diameter. It is also advisable to cover the external surface of the column with three to four layers of asbestos paper in order to decrease heat losses.

The process of distillation does not separate the water vapour from volatile constituents such as dissolved gases and certain organic substances which are volatile at the distillation temperature. There is, however, a difference between dissolved gases and other dissolved volatile substances. The process of boiling transfers the dissolved gases completely into the vapour phase, whereas only a fraction of the dissolved volatile substances is transferred into the vapour phase, depending of course on the values of the saturated vapour pressures at the distillation temperature. One point deserves mention, because it is usually neglected when the pros and cons of distillation *versus* other schemes of purification of water are considered. When solutions capable of forming minimum boiling mixtures (containing excess water) are used, the process of distillation results in the distillate containing a higher proportion of the impurity than that of the tap-water used. This principle applies to such mixtures as ethyl alcohol and water; indeed fractional distillation is used in this case in the preparation of a constant boiling mixture of alcohol and water having c. 95·6 per cent alcohol. The presence of alcoholic impurities, and indeed that of any non-electrolytes, cannot be detected by pH or conductivity measurements. The removal of organic substances is usually effected by adding some alkaline permanganate to the distillation flask where they are oxidized to CO_2 and water.

Such addition can be made conveniently to units in which the distillation chamber is made of glass. If a metal distillation chamber is the only type available, alkaline permanganate is likely to attack the metal; consequently this method cannot be used.

The Heat Supply to the Still

The type of heat supply and its method of application in the distillation system deserve consideration.

On the whole it is preferable to rule out the use of gas heating because of its inconvenience compared with electricity and because of the resultant increase in the carbon dioxide content of the atmosphere. The latter factor can be a nuisance in that several laboratory experiments require CO_2 absence, as any increase in the carbon dioxide content of the atmosphere results in the need for more extensive precautions in the carrying out of such experiments, e.g. in the titration of weak acids with alkalis where the pink colour obtained at the end point, using phenolphthalein, is affected by the presence of carbon dioxide in the atmosphere. The carbon dioxide may be removed from the titration vessel by the passage of air which has been passed through sodium hydroxide solution; when the carbon dioxide content of the atmosphere is increased, it is necessary to ensure more prolonged contact between the pumped air and the CO_2 absorbing sodium hydroxide solution.

Available electrical heating systems may be placed in two main categories:

(*a*) *External heating using an asbestos or glass fibre mantle.*—Heating mantles are used quite extensively and conveniently for many distillations such as those involved in organic chemistry. They are made in forms which heat either the lower part of the distillation flask, sometimes associated with a separate mantle which is used to heat the upper part of the flask, or in a fit-on type of mantle which covers practically all the flask with the exception of the neck.

For continuous water distillation to be economical and as rapid as possible, it is desirable that the heating mantle should cover as much of the distillation flask as possible.

However, such an arrangement does not allow direct vision of the water level inside the flask and thus increases the chances of accident. This particularly applies in hard-water districts where the rapid accumulation of hard-water deposits resulting from the distillation makes it essential to clean the distillation flask each day. In systems which do not possess an outlet at the bottom of the distillation flask, and which therefore must be dismantled for acid cleaning to remove the carbonate deposits which adhere to the internal surface of the vessel, separate upper and lower mantles have to be used in order to decide whether the cleaning process is satisfactory. If close fitting mantles are used, the sulphuric acid added in some laboratories to the distillation flask* may occasionally find its way to the mantle with deleterious effects. On the whole, the external mantle method can be conveniently used only when special modifications have been employed in the water distillation flask. In this laboratory we have noticed that when such mantles are continuously used for water distillation with 'anti-bump', the distilling flask becomes internally etched or devitrified within less than a year. Once the glass is thus affected it is advisable to discard the flask and to use a new one. Any attempt at economy in this connection is bound sooner or later to result in a costly failure.

(*b*) '*Internal*' *heating.*—The water may be heated internally using an electrical resistance wire which is usually covered by an insulating material.

A modification of this method consists of a prominent internal indentation in the bottom of the flask into which is fitted an electrically heated spiral wound on a suitable frame. This method has been found to be very stable and compares favourably with the external lower mantle system, though the latter is obviously superior when applied under discontinuous conditions not involving deposits.

*This combines with any NH_3 present and thus stops its transfer to the vapour phase. Further, the sulphate complexes with the Ca^{++} and Mg^{++} ions and decreases effectively the deposition of $CaCO_3$ and $MgCO_3$ deposits.

Bumping

Violent bubbling may be encountered during the distillation. To counter this, pumice 'anti-bump' is usually added to the distillation flask. It is, however, possible nowadays to buy distillation flasks the internal surfaces of which have been suitably treated so as to result in steady bubbling.

The Distillation Flask

The distillation flask in a glass still should of course be made of resistance glass. It should have an outlet at its bottom ending in a standard joint. This will simplify cleaning without dismantling of the distillation apparatus.

Removal of Dissolved Gases

The removal of carbon dioxide and other dissolved gases from distilled water is carried out in a number of laboratories by allowing part of the water vapour to escape, while the rest is being condensed. The 'bleeder' which allows the escape of steam must be situated near the bottom of the condenser. The method is sound, but it is essential to make certain that the steam escapes continuously and not in batches. The disadvantage of this method is that the steam escaping into the laboratory atmosphere tends to raise its relative humidity.

Instead of using the last method one may employ a partial vacuum. We advocate that the bleeder be connected to a water pump which would ensure that the excess steam carrying the unwanted gases be sucked down into water stream instead of being allowed to escape into the atmosphere.

The distilled water may be stored in resistance glass such as Pyrex or in polythene containers. If it is to be kept for some time, it should be kept away from light. Experience shows that 'equilibrium' water containing CO_2 on several weeks exposure to light in the laboratory sustains growth of algae.

Living in an automation era, as we do, it is surprising to find that many laboratories still do not use automatic controls of water distillation units which, on the whole, are savers of time, energy and worry. From the standpoint of labour economy alone, it is possible to make a formidable case for the installation of automatic cut off and on switches in water purification processes.

Some inherent resistance to the installation of such automatic systems is often encountered. The arguments occasionally heard involve the standpoint that increase in automation results in increased dependence on such systems which may eventually get out of hand. Also, that the time spent in checking the working of such gadgets, the numbers of which are steadily increasing, may before long become so increased that any time saving will be offset in the long run.

An argument sometimes advanced is that the introduction of mechanization and automation processes into the home have not made life any simpler for the housewife, but have simply shifted the emphasis from one working field to another. For example, it has been argued that the introduction of an electric time-automatic mixer in the kitchen does not save the housewife any work, but merely makes her spend less time on *manual mixing* and more time on dismantling the machine, washing and drying its constituents; further, if the machine goes wrong then it is not possible, at any rate until it is repaired, to prepare foods that do require such action. This argument is sometimes advanced by a husband who is attempting delaying tactics where a determined mechanically minded housewife is concerned. More often than not it is not successful, because the husband himself does not really believe in the argument, as he appreciates that his attitude is affected by other considerations. One often suspects that the attitude of scientific phlogistonists* is based essentially on the attitude of 'What was good enough in my student's days is good enough for me now'. This attitude may be acceptable in ethics, tolerable in general life, but must be rejected in the scientific field where progress is accelerating because of the development of new methods and techniques. Should one consider that such negative attitude is rare among scientists, then one may be readily disillusioned on the subject. One has but to recollect the example of Ignaz Semmelweis who tried to introduce the concept that puerperal fever in gynaecological operations was passed on to women by contact with the hands of medical practitioners and students who had come straight from post mortem examinations. He was not only ridiculed, indeed the treatment he received amounted almost to persecution. And this was a case where human life was in the balance! We may add to this the scepticism, which in some cases amounted to condemnation, which greeted the enunciation of new theories such as those advocated by Lister, Darwin, and Einstein. Looking back at the language used in the attacks on the people enunciating new ideas, one is indeed appalled. The attacks might often be ascribed to some personal rather than scientific reasoning. Phlogistonism may indeed flourish in the minds of some scientists in every generation, and the resistance to introduction of automation in the laboratory may be but one manifestation of it.

Automatic electrical supply cut off systems which operate when the supply water level to the still is too low, or when the receiving vessel is full, and which are reversed as soon as these factors are reversed, are available commercially. They should be attached to distillation systems whatever opposition is encountered.

Ordinary chemistry laboratory requirements for making aqueous solutions in qualitative and quantitative analysis are usually satisfied by a single distillation water quality which, when suitable precautions are taken, is practically CO_2 and NH_3 free. Such water has a specific conductivity of 1×10^{-6} ohm^{-1} cm.$^{-1}$ and a pH value of ca. 6·0 to 6·3. If however diffusion of CO_2 from the atmosphere is allowed to take place, the

*In this sense a phlogistonist is defined as a die-hard 'scientist' who is against the introduction of new methods, techniques, or ideas into the laboratory.

specific conductivity may rise to 3×10^{-6} ohm^{-1} cm.$^{-1}$ and the pH may go down to less than 5. Experiments in this laboratory using singly distilled water (from a good still) which was allowed to absorb atmospheric CO_2 and which was subsequently degassed by boiling, resulted in the pH value rising to 6·5. A quarter of an hour's bubbling of nitrogen through the above non-boiled singly distilled water resulted in the pH value rising to pH 6·3* and the conductivity value decreasing to $1{\cdot}5 - 2 \times 10^{-6}$ ohm^{-1} cm.$^{-1}$, both values referring to 20°C. measurements.

A second distillation under final conditions which ensure absence of acid or alkaline gases results in the specific conductivity decreasing to ca. 1×10^{-7} ohm^{-1} cm.$^{-1}$, while the pH value rises to the range of 6·4-6·7 at 20°C.

As pH values are regularly quoted in the literature, often without temperature specification, it is desirable to consider the significance of such measurements over room temperature which may vary during the year over the average temperature range of 18°C. to 25°C. The pH of neutral water is calculable from the dissociation constant of water K_w. The value of K_w is temperature dependent. At 18°C. it is approximately between the values of $0{\cdot}52 \times 10^{-14}$ to $0{\cdot}59 \times 10^{-14}$. (Heydweiller 1909, Harned and Hamer 1933), while at 25°C. it is $1{\cdot}0 \times 10^{-14}$. In pure water, the relation $[H^+]\,[OH^-] = K_w$ is accurate, and then $[H^+] = [OH^-]$ from which we obtain $[H^+] = 10^{-7}$ at 25°C., while at 18°C. it is roughly $10^{-7{\cdot}13}$.

Correctly defined in terms of activities,

$$pH = -\log\left(\alpha_{H^+}\right)$$

where α_{H^+} is the activity of the hydrogen ion. However, in pure water—or in dilute solutions where the electrolyte concentration is below 10^{-5} M—we can safely assume that the activity of the ion equals its concentration and then

$$pH = -\log[H^+]$$

Consequently, under such conditions the pH of neutral, pure, water at 25°C. is 7·0, while that at 18°C. is ca. 7·13. The effect of temperature on the value of the pH scale itself, while not negligible in itself, is small compared to the effect of the introduction of CO_2.

Ion Exchange

The ion-exchange process of water purification depends on the passage of the water over both a cation exchange resin in its acid form and an anion exchange resin in its base form. The cation exchange resin exchanges an H^+ for the cations present in the water, thus,

$$\underset{resin}{2\,A^-H^+} + \underset{aqua}{Ca^{++}} \rightleftharpoons \begin{cases} \underset{resin}{A^-}\,Ca^{++} \\ + \\ \underset{aqua}{2\,H^+} \end{cases}$$

The anion exchange resin exchanges a hydroxyl ion for the anion in the water, thus

$$\underset{resin}{C^+\,OH^-} + \underset{aqua}{Cl^-} \rightleftharpoons \underset{resin}{R^+\,Cl} + \underset{aqua}{OH^-}$$

Both exchanges are reversible, but as long as the cation resin and the anion resin are respectively predominantly in the acid and basic forms, both reactions will be practically completely displaced to the right.

Now, for electrical neutrality in solution, the total number of positive charges must equal the total number of the negative charges. Consequently, the final result should be the combination of equal numbers of substituted OH^- and H^+. And since $H^+ + OH^- \rightleftharpoons H_2O$, the overall process of ion exchange results in the formation of water and thereafter of deionization accompanied by production of more water.

The efficiency of such processes depends within limits on the quantity of resins available and also their distribution. Ion exchange purified water equivalent to that of single distilled 'equilibrium' water is often prepared by a two-stage deionization involving the passage of the water through a cation exchange resin followed by an anion exchange resin.

The commercially available deionization units have usually attached conductivity measuring systems which include a conductivity cell with bright platinum electrodes, a conductivity bridge and conductivity meter. When the conductivity rises above a given value the two exchange resins have to be regenerated; the anion resin is regenerated with sodium hydroxide, the cation resin with hydrochloric acid. When very pure water such as conductivity water is required, the two stage deionization is followed by passage through a third column which contains a mixture of the basic form of the anion and the acid form of the cation resins and which is usually referred to as mixed bed deionization. Such a combination is more effective than that arising from the use of *separate* ion exchange resins. Further, any minute traces of soluble material which originate from one resin are taken up by the other, thus eliminating any contamination of the water by the separate resins.

The mixed bed deionized material is not easily regenerated, but its use results in very pure water having a specific conductivity as low as $6{\cdot}5 \times 10^{-8}$ ohm^{-1} cm.$^{-1}$.

One point concerning the use of ion exchange in water purification is not sufficiently emphasized, viz. that of the pH of the emergent 'pure' water. Experience has shown that though the conductivity of the water, as measured by the conductivity meter attached to the ion exchange unit, was within the 'permissible' range, the pH value of the water was over pH 8. This incidence

*These pH values are the pH values recorded using glass electrode measurements at 20°C. (For details of accurate constant temperature pH meter measurements, see Lewin (1953, 1955). It must be emphasized that these values are the first values recorded before CO_2 diffusion into the glass electrode compartment could take place. If one follows the pH of the water as atmospheric CO_2 diffuses in, say after the first half a minute when the measurements are quite stable, the pH value is seen to decrease slowly.

may be disturbing at first sight, but it is indicative of the meaning of conductivity measurements in relation to pH, as will be seen from the following calculation:

Let the pH of the water emerging from the deionizer be pH 8. This is equivalent to a $[OH^-] = 10^{-6}$, and $[H^+] = 10^{-8}$. Assuming the cation to be Na^+ (it will be remembered that the anion exchange material is regenerated with sodium hydroxide), we have for electrical neutrality $[Na^+] = 10^{-6}$, since the concentration of the H^+ is but one per cent of this. The pH value of 8 in the emergent water can therefore be ascribed to its being an extremely dilute solution of [NaOH] = 10^{-6}N. Now, the ionic conductivities of the constituents are*

H, $\lambda_+ = 349{\cdot}82$; Na, $\lambda_+ = 50{\cdot}11$ and
OH, $\lambda_- = 198{\cdot}5$ ohm^{-1} cm.^{2}

and the equivalent conductivity of an electrolyte by definition is

$$\Delta = 1000 \times \left(\frac{k}{C}\right)$$

where k is the specific conductivity and C is the concentration in moles per litre. Rewriting we have

$$k = \frac{\Delta C}{1000}$$

Therefore

$$k_{OH^-} = \frac{198{\cdot}5 \times 10^{-6}}{1000} = 2 \times 10^{-7}$$

$$k_{Na^+} = \frac{50{\cdot}11 \times 10^{-6}}{1000} = 0{\cdot}5 \times 10^{-7}$$

$$k_{H^+} = \frac{349{\cdot}82 \times 10^{-8}}{1000} = 0{\cdot}03 \times 10^{-7}$$

and since the specific conductivity of the solution as a whole is equal to the sum of the individual specific conductivities of the ions in solution we have for the water emerging at pH 8 a specific conductivity of ca. $2{\cdot}5 \times 10^{-7}$.

It can be similarly calculated that if the pH of the water emerging from the ion exchanger is pH 9, then the specific conductivity of the solution is ca. $2{\cdot}5 \times 10^{-6}$ ohm^{-1} cm.$^{-1}$.

Vendors of ion exchange water purification units often state that the specific conductivity of the emergent water is between 5×10^{-8} to 5×10^{-7} ohm^{-1} cm.$^{-1}$. These figures, if due entirely to contamination with sodium hydroxide, can be explained in terms of the slightly alkaline pH values as shown above.

Indeed, experience has shown that the pH of the water emerging from the deionizer is often near pH 8 and sometimes a little higher. When such deviations are noted it is of course customary to wonder whether the laboratory steward has indeed washed the regenerated ion exchange unit properly. As the first principle in science is to take nothing for granted, one proceeds to carry out the regeneration on one's own, only to find that one has to retract inwardly the original doubts as to the meticulousness of the laboratory steward.

The high pH value is often missed because of the practically zero buffering capacity of such water. The emergent deionized water may well have a pH of 8 or over. The person detailed to measure the pH of the water may collect the water from the container using a beaker. Naturally, the deionized water mixes with the atmospheric air as it enters the beaker and enough CO_2 may be absorbed to lower the pH value to something very close to 7, when it is measured in the pH meter. When precautions are taken to exclude contact with the ordinary atmosphere while the water is drawn from the container, then the pH of the emergent deionized water may well approach and even exceed pH 8. I know at least one ion exchange deionizer salesman with a surface knowledge of chemistry who like other salesmen tried to 'prove' how neutral the water was by pH measurements. He was uncomfortable when he was shown that it was slightly alkaline.

There are now several kinds of commercial ion-exchange deionizers including a system involving three different resins. Consideration of the various types will have to be undertaken separately. The main question with which one is confronted is this: Should one buy a still—and if so what kind—or should one buy an ion exchange unit?

The use of either system involves an initial outlay, routine cost and attention. The cost of a good metal still—with a well-tinned condenser—using a 1·5 kilowatt heater and which delivers about three pints per hour is in the region of £19, not allowing for any cut-off and switch-on electrical accessories.

At 1·5 pence per kilowatt, the cost per gallon is approximately 6d. If a larger still is used—say a three kilowatt one—with a delivery rate of ca. eight pints per hour—in which the heat losses are smaller, the cost reduces to about 5d. per gallon. The figures quoted are independent of the degree of hardness of the water, though a little more work is involved in ensuring the complete removal of hardness of water deposits in hard water districts.

An all-resistance glass still producing less than three pints per hour—without the distilled water container, and without the switch-on and cut-off electrical accessories, costs about £17. The cost of the electrical distillation is also about 5d. per gallon, allowing for the 'bleeding' of some steam which ensures a practically CO_2 free distilled water.

An all-resistance glass still including distilled water container and automatic cut-off and switch-on systems, which operate either when the tap-water supply has failed or when the distilled water reservoir is full, costs about £26, the emergent water cost being about the same as above.

*The values quoted are those for 25°C. Variation in temperature results in slight variation of the values.

The cost of a two-stage deionizer depends on its capacity. Its cost is about £80 to £100 where a total capacity of about 300 litres (67·5 gallons) is considered. The cost per gallon of deionized water varies considerably with the degree of hardness of water. In hard water areas such as London and Sunderland, it may be as high as 0·3d. to 0·4d. per gallon according to the makers' claims which are a little optimistic.

The answer to the question as to which purification system one should purchase—when ordinary quality water of ca. 1×10^{-5} to 5×10^{-5} ohm^{-1} cm.$^{-1}$ specific conductivity is required—depends on the availability of the money, whether the system is direct or not, and on the total water delivery requirements. The question of cost is, however, not as simple as might appear at first sight. The calculations do not include the labour costs in attending to the purification systems. When the metal still or the all-automatic glass still is considered, attention is indeed minimal, particularly when the distillation flask has an outlet at its lower end which ensures rapid cleaning and flushing. In the case of the deionizing system we have neglected to take into consideration the labour cost required in regenerating the system. The preparation of the sodium hydroxide and hydrochloric acid solutions, and the attention required during regeneration, may take from two to three hours. This takes place approximately once per 65 gallons. Assuming the labour cost to be roughly 10s. it adds about 2d. extra per gallon to the deionized water. It might be argued that the laboratory assistant is in the laboratory any way and is not paid separately for the regeneration. However, if this attitude is accepted, it might be argued that the cost of the electrical distillation is not borne directly by the laboratory, at least in educational and research establishments, but is merely part of the overall cost.

If one is in doubt, then one good compromise adopted in a number of laboratories is to buy both a still and a deionizing system. The water is distilled and then passed through the deionizing unit. As the distilled water contains only traces of electrolytes, which are removed by the subsequent deionizing, as much as 10,000 gallons of distilled water may be passed through the deionizer before it requires regenerating. By this means, particularly when mixed-beds are used, very pure water may be obtained.

We would also advocate consideration of another scheme which combines cation exchange with distillation in hard-water districts. This involves the passage of the tap-water first through a column of the acid form of a cation exchange resin where the Ca^{++} and Mg^{++} ions are removed, thus ensuring absence of hard water deposits in the distillation chamber. The still should have a good spray remover and a 'bleeder' connected to a water pump and an opening at the lower end of the distillation chamber which allows ready flushing.

The cost of the cation exchange column is quite small. It can be constructed easily in the laboratory by using glass-tubing which is simply filled and blocked at both ends using rubber bungs with glass inlets and outlets. No conductivity measuring system need be used, as regeneration should be carried out when the first hardness deposits are noticed on the distillation flask.

We would also advocate that the subject of water purification should be emphasized in the teaching of chemistry as an entity which allows correlation, contrast and comparison of various tools and techniques illustrating important physico-chemical principles, some of which it was not possible to discuss with any justice in a short article. Not only should the principles of distillation, ion exchange and electrodialysis be considered, but other related problems such as their effect on the separation of D_2O from H_2O during the purification process, since the respective boiling points and equilibrium constants of these products differ significantly.

REFERENCES

Heydweiler (1909). Ann. Physik, **28**, 503.
Harned and Hamer (1933). J. Am. Chem. Soc., **55**, 2194.
Lewin (1953). Chem. & Ind., 1193.
Lewin (1955). Lab. Practice, 441.

Society for Applied Bacteriology

The 1960 Annual Meeting and Summer Conference of the Society will be held in Bangor on Tuesday, Wednesday and Thursday, July 5, 6 and 7, members assembling on Monday, July 4.

The meetings will be held in Neuadd Reichel, University College of North Wales, Bangor and accommodation will also be provided at Neuadd Reichel.

Members may introduce friends on all occasions except at the Annual General Meeting, and a conference fee of 5s. will be payable by all attending the Conference or any part of it.

The programme will be as follows:

July 4, Monday

Afternoon	Arrival of Members
8 p.m.	Meeting of Committee

July 5, Tuesday

9.30 a.m.-12.30 p.m.	Paper-reading Session
2.15 p.m.-4 p.m.	Paper-reading Session
5 p.m.	Annual General Meeting

July 6, Wednesday

9.0 a.m.-12.45 p.m.	Symposium on *Pseudomonas* and *Achromobacter*
2.15 p.m.-6.15 p.m.	Excursions to Snowdonia or Anglesey
7 p.m. for 7.30 p.m.	Society Dinner

July 7, Thursday

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SPECIAL PREVIEW

LABORATORY APPARATUS and MATERIALS EXHIBITION

JUNE 20-21-22-23 1960

Royal Horticultural Society's New Hall
Westminster, London, S.W.1

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SPECIAL PREVIEW ➤

LABORATORY APPARATUS and MATERIALS EXHIBITION

JUNE 20-21-22-23 1960

Royal Horticultural Society's New Hall

Westminster, London, S.W.1

What to see at the—

LABORATORY APPARATUS AND MATERIALS EXHIBITION

The Laboratory Apparatus and Materials Exhibition, sponsored by Laboratory Practice and organized by U.T.P. Exhibitions Ltd., is the first of its kind to be held in the United Kingdom on a national scale, where products and materials on show are limited to those specially produced for use in all types of laboratories. In addition a comprehensive series of lectures on recent advances in laboratory techniques by specialists in their field will be given throughout the entire run of the Exhibition, the full programme for which appears later in this special supplement. Daily glass blowing demonstrations will also be given on stand 67 by Mr. J. A. Frost of Reading University.

For the first time, under one roof, practically every possible laboratory requirement will be available for examination, study, comparison and selection as will be evident from the following descriptions of exhibits.

Aimer Products Ltd. (Stand No. 7)

The majority of the exhibits to be displayed on this stand have been designed and approved by well-known doctors and technicians, and have been found to be invaluable in all forms of chemistry research in Great Britain, and throughout the world, including Australia, Africa, New Zealand, U.S.A., Canada, West Indies, South America, Europe, China, India, Ceylon and Russia.

The chromatography apparatus was designed by Dr. Ivor Smith and Dr. J. B. Jepson, together with others, of the Courtauld Institute and Barnato-Joel Laboratories of the Middlesex Hospital Medical School, London, W.1, and they are being used most successfully at home and abroad.

The Kemikit small scale apparatus is to the design of Dr. Stock (now teaching at Connecticut University) and Mr. Fill of Norwood Technical College. This apparatus is being used extensively, with great success, at many Universities and Technical Schools in this country, as well as abroad, and is able to cope with all that is required in the field of microchemistry.

The 'Portalab', designed by Dr. H. Medinger, is claimed be the most compact laboratory in existence. It is invaluable to schools that are restricted for space as far as science teaching is concerned, and for students who are hoping to obtain a very high level in G.C.E. In large schools one 'Portalab' to three or four students is admirable.

In addition to the above, other items will be exhibited and the company will welcome all enquiries.

Anderman & Company Ltd. (Stand No. 32).

Porcelain, glassware, chemicals, refractories, and electric stirrers will be featured on this stand.

The porcelain will be the famous Royal Berlin porcelain with its excellent resistance to thermal shock and chemical attack.

Jena glassware for laboratory use will also be shown. Of particular interest will be G.20 glass with its high resistance to chemical attack. A Jena water bi-distiller which will produce 4 l. of bi-distilled water per hour will also be shown.

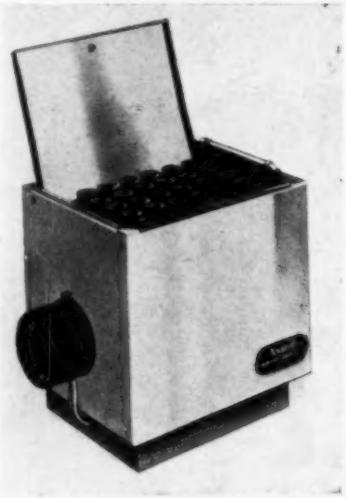
Examples from the range of Merck reagents will be displayed including indicator papers and 'Titrosol' concentrated volumetric solutions. The refractory tubing and shapes for many purposes to be shown will be of particular interest owing to the range of sizes available, and the very close tolerances to which they can be supplied.

The Anderman variable speed stirrer will be demonstrated and visitors can test the high torque obtainable at all speeds by use of the multitapped transformer control. The stirrer can be used at speeds ranging between 60 and 7,000 r.p.m. and a comprehensive range of stainless steel paddles are available for use with it.

Astell Laboratory Service Co. Ltd. (Stand No. 23).

This company will exhibit a selection of equipment for use in modern laboratories covering the fields of chemistry, microbiology, laboratory control and laboratory furniture, with particular application to the dairy and food industries.

Some of the exhibits are new; some traditional equipment has been re-designed and mechanized in the interests of speed, accuracy and safety, while other units have been developed to meet exacting techniques in the ever-expanding field of microbiology and biochemistry.



Astell water bath.

(*a*) Included in the exhibits will be the Astell fully-automatic refrigerated Hortvet cryoscope, semi-automatic and standard models, carefully designed to ensure compliance with Hortvet test conditions prescribed in B.S.S. 3095:1959 and the A.O.A.C. In the semi-automatic model (501) mechanical devices have been incorporated to overcome the tedium of hand manipulation of stirring and variable supercooling. This model has now been further modified (501/A) to include automatic ether replenishment, which considerably minimizes the inflammability hazards in the use of ether in a general laboratory.

The fully automatic model (502) employs additional special features to effect absolute reproducibility of freezing conditions and results. As many as 15 freezing point determinations can be carried out per hour and the ether hazard is completely eliminated by the use of a secondary refrigerant.

(*b*) The Astell Gerber centrifuge which is available either with fully enclosed vertical loading cups or with the conventional type horizontal loading pan.

(*c*) Semi-automatic fillers, representing a major advance in the method of filling Gerber butyrometers with sulphuric acid and amyl alcohol. They ensure complete safety to the operator, speedy and accurate filling, and are virtually non-drip. The stands are polythene covered to prevent corrosion.

(*d*) The automatic lactometer jar, a sturdy, attractive apparatus designed to speed up and simplify the whole process of making lactometer (hydrometer) readings. The exhibit includes all further equipment required for milk testing and, of special interest, the rapid solids-not-fat calculator.

(*e*) A low temperature incubator by which automatic and accurate control of incubation at any temperature in the range 5—40°C. is now possible.

(*f*) Equipment for the manufacture of phage-free cheese starters. Air-borne infection has been eliminated in a new method of starter propagation evolved by Mr. E. J. Lewis of United Dairies (Wholesale) Ltd. (J. Soc. Dairy Technology 1956, **9**, 123-130) and the company manufacture all the specialized equipment needed for this new technique.

(*g*) Roll tube equipment for bacteria counts.

(*h*) Bacteriological seal, used instead of cotton wool for plugging Astell roll tube bottles and $\frac{3}{4}$ in. diameter (15/16 mm.) test tubes. Its use represents a major saving in time as well as cotton wool. Unlike ordinary rubber stoppers, this seal is specially designed to vent automatically when the bottles or test tubes containing media are heated for sterilization. After sterilization, the seals are pressed home. Media plugged in this way will remain sterile indefinitely and there is no evaporation during storage.

(*i*) Thermostatically controlled Water baths, hot air sterilizers and incubators.

(*j*) Automatic media filler, disposable Petri dishes, microassay plates, and equipment and media used in bacteriological examinations.

W. & R. Balston Ltd. (Stand No. 59)

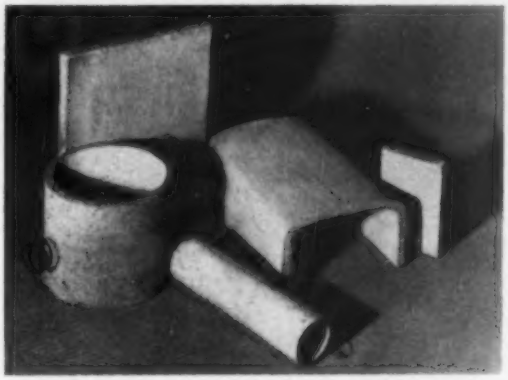
The exhibit will be arranged in four groups as follows:

Filtration.—This will include the normal range of Whatman laboratory filter papers. In addition two recent developments, silicone impregnated papers for the separation of aqueous and non-aqueous liquid phases, and glass fibre papers which have proved to be extremely useful for other difficult filtration problems where very high retention is required.

Chromatography.—The various special shapes and grades of paper evolved for this technique, are represented in this group.

Cellulosic Ion-Exchangers.—These are the latest addition to the Whatman range and include such materials as diethylaminoethyl cellulose (DEAE), ECTEOLA cellulose, aminoethyl cellulose (AE), cellulose phosphate (P), cellulose citrate (CT), and carboxymethyl cellulose (CM). All these products are represented in three physical forms: flocs, powders and papers.

Glass Fibre Papers.—In addition to the normal type of filtration application mentioned above, these papers are featured here as high efficiency air filters with emphasis on their use in dust sampling from the atmosphere.



Barlow-Whitney moulded electric heating elements.

Barlow-Whitney Ltd. (Stand No. 53).

The following will be shown on this stand:

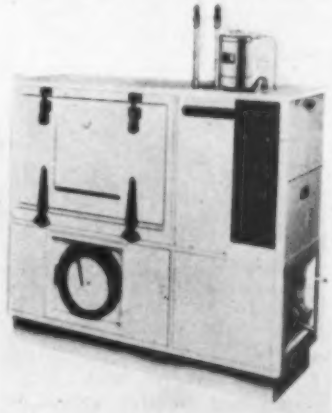
Humidity Test Cabinet.—The model HTC.2B humidity test cabinet exhibited is one of the smaller units of the 'B-W' range for the testing of electrical and electronic components, tele-communication equipment, packaging, paints and varnishes, plating finishes, etc. All units are completely self-contained.

Performance characteristics include: dry heat to 100°C.; wet heat to 70°C.; relative humidities from 40 per cent to 99 per cent; temperature control limits ± 0.5°C. or better; controlled rapid cyclic temperature variation under damp heat conditions with adjustment for amplitude and frequency.

Other units are available for mould or fungus growth tests and with refrigeration for temperatures down to 0°C., also large tropical chambers with capacities up to 9 feet cube or to special dimensions.

Furnaces.—A number of types from the 'B-W' range will be exhibited including muffle and tube furnaces and also units for operating temperatures to 1,500°C.

Moulded electric heating elements shown on this stand are a recent addition to the company's products. They provide



Barlow-Whitney humidity test cabinet.

a convenient and economic answer to many of the higher temperature heating problems which arise so frequently on experimental and prototype work.

The variety of shapes which can be supplied enables temporary heating chambers and tunnels to be easily built up in the laboratory or research department and special forms can also be made for permanent installation in production equipment.

These moulded elements are rigid self-supporting units manufactured under carefully controlled conditions to a technique developed after extensive experimental work and field tests. Two types are available—Series E.1,000 MHE to 1,000°C. and Series E.1,200 MHE to 1,200°C.

The following typical items are also to be exhibited:

Ovens for drying, curing and other heat processes.
A small vertical vacuum oven.
A vertical crucible furnace.
High temperature melting pot suitable for zinc, lead, tin, etc.
A selection of melting pots for waxes, compounds, white metal, etc.
Hot plates.
Litz wire strippers.
Removable core type heaters.

Boro' Laboratories & Appliance Co. Ltd. (Stand No. 30).

A comprehensive range of laboratory glassware—E-mil, Davisil, Firmasil, Monax, and Pyrex—will be shown, together with temperature controlled water baths, centrifuges, sampling outfits, insulated carrying cases, filter papers, Oxoid preparations, thermometers, and anodized aluminium test tube baskets.

The display of plastic laboratory ware in polythene, polystyrene, nylon, P.V.C., etc., will include aspirators and beakers, bottles, funnels, measuring cylinders, pipette cylinders and washers, stoppers and test tubes; also tubing rod and sheet in polythene, P.V.C. and nylon.

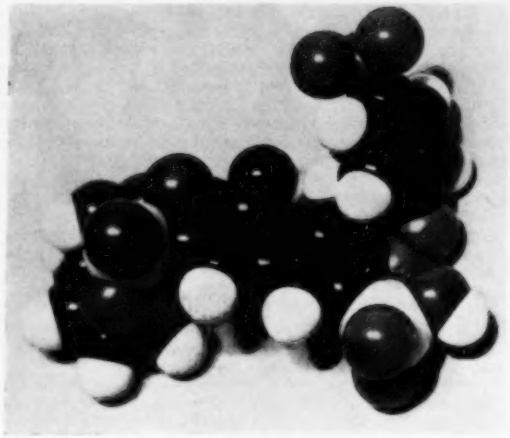
Terylene laboratory coats and aprons will also be shown on this stand.

The British Drug Houses Ltd. (Stand No. 24).

The plant and warehouses of the B.D.H. Laboratory Chemicals Division at Poole supply between 6,000 and 7,000 products for laboratory use; each year the Division issues scores of thousands of copies, mostly free, of technical booklets and other publications, and circulates nearly a quarter of a million informatory leaflets on reagents and preparations newly available for analytical and other laboratory procedures.

While the B.D.H. stand will indicate something of the range of the Division's activities, enquirers will find the company's 1960 catalogue offers a choice of products and an amount of information about them which are even more extensive than in previous editions. Including 'AnalaR' and M.A.R. products, specifications of purity are now given for nearly 2,000 substances, with formulae, molecular weights and liquid densities. In particular, the biochemical section has been greatly enlarged, and materials for liquid and gas chromatography, solvents for spectroscopy, concentrated volumetric solutions, ion exchange materials, and molecular sieves are examples of the newer products which have become available to laboratories in steadily increasing variety during the last few years.

The Camlab Transistavolt.



Model of naphthol blue/black 'B' molecule. (*Catalin Ltd.*)

Equally, recent years have seen rapid and extensive developments in the production of pure chemicals for direct industrial use. For special fields of industry the company supply, in addition to general organic and inorganic chemicals, fluorides in very large quantities, selenium and tellurium compounds, and salts of caesium and uranium. Visitors interested in technological applications of pure chemicals will be able to discuss their problems with the company's technical representatives.

Camlab (Glass) Ltd. (Stand No. 47).

As a result of recent advances in electronic techniques, including in certain applications the use of transistors as an alternative to valves, and a general improvement in mains stability, stabilized power supply units are now much more reliable, more compact and less expensive.

The 'Transistavolt' unit to be shown by this company has recently been tested in the Unicam Research Laboratory under normal operating conditions, as a result of which it was found that the unit provides a voltage source of adequate stability for the tungsten lamp and amplifier voltage L.T. of the Unicam SP.500 spectrophotometer. Interdependence of dark current and sensivity controls was unobserved using the Transistavolt. It was not possible to carry out endurance tests on this unit.

This equipment has been specially designed for purposes demanding a low-voltage supply of highly constant d.c. voltage and especially for laboratory use by spectophotometry, etc., where previously a sufficient constancy was only obtainable by means of trouble-causing storage batteries.

A new item to be shown on this stand is a device for clinical biochemists and haematologists to enable them to produce very accurate and highly reproducible dilutions of blood for flame photometry and haematology.

Catalin Ltd. (Stand No. 41).

The Catalin exhibit will consist of the following:

(*a*) *Covalent Models.*—Catalin standard, student and teaching sets of covalent atoms based upon the Stuart Pattern and developed in conjunction with the Chemical Research Laboratory at Teddington, together with models of a variety of molecules illustrating their use. These models

are coloured in accordance with the recommendations of the Institute of Physics and are accurately made to a scale of 1 cm.≡1Å. They comprise 11 elements in their various valency states and spacial arrangements. They are particularly useful both for the teaching of organic chemistry and as a guide in planning research into the structure of complex molecules.

(*b*) *Ionic Models.*—A new series of ionic models together with an adjustable base (patent applied for) designed by Mr. J. E. Whitney, which are intended as visual aids for the teaching of inorganic chemistry. The adjustable base enables a wide variety of model compounds to be constructed at minimum cost and also permits both exploded and close packed forms to be demonstrated.

The individual ions are dimensioned in accordance with Paulings concepts and are made to a scale of 1 cm. 1 Å. They are coloured characteristically, the electro positive ions by opaque colours and the electro negative ions by transparent colours. A series of model inorganic compounds will be shown based upon various alkali metal halides and cadmium iodide in order to demonstrate the influence of ion size upon packing and to illustrate the radius ratio effect. It is proposed to offer these models with both fixed and adjustable bases.

By employing the Catalin ionic models in conjunction with the covalent models, a much broader range of visual aids to the teaching of chemistry becomes available than hitherto.

Communication Systems Ltd. (Stand No. 37).
This stand is shared by Hivac Ltd. and Communication Systems Ltd., two companies in the A.T.E. group.

Communication Systems Ltd. will be exhibiting the A.T.E. crystal chronometer, a new all-electronic precision pulse source with a time interval accuracy of the order of a few seconds per annum. It employs a crystal-controlled oscillator to generate a basic frequency which is fed to a series of binary dividers. The outputs of the binary dividers are fed to separate pulsing relay circuits to produce pulses at the required intervals. The special circuits are completely transistorized and make extensive use of printed circuit panels of the plug-in type. The standard chronometer for general application produces three square wave pulses at intervals of 1, 30 and 60 seconds respectively but other pulse output rates can be provided.

Hivac Ltd. will be showing subminiature valves, cold cathode tubes, lamps, dry reed relays, in-line digital display tubes and other small specialized electronic devices.

Alfred Cox (Surgical) Ltd. (Stand No. 27).
This display is presented in an endeavour to assist pathologist and anatomist.

The technique of post-mortem examination cannot, of necessity, advance to any appreciable extent. The aim is, therefore, to concentrate on the production of dependent instruments of the recognized patterns. This firm has specialized in the making of such instruments since 1860 and the instruments and equipment offered cover a range to meet all normal requirements in this field. Special attention has been given to the needs of the forensic pathologist and many items have been developed and adopted to facilitate this highly specialized work.

The need for improving design of necropsy tables has long been recognized and it is thought that the table which will be on view combines all the features desired by both pathologist and mortuary staff.

The importance of the cleansing of laboratory glassware need not be stressed and in order to simplify this process and eliminate the risk of residual deposits, Haemo-Sol has been introduced into this country from the United States of America where it has been in continual use in the principal hospitals for over eighteen years. A comprehensive technical bulletin will be available with simple guidance for use and supporting data and experimental methods of proving its efficiency.

Biophysics Department of University College, London.
(*Cygnet Joinery Ltd.*)

Cygnet Joinery Ltd. (Stand No. 52).
Units of standard production, both fixed and removable type under-bench units, will be shown on this stand. In the latter case, these are interchangeable if of a similar module. The exhibit will be partly pictorial illustrating the wide range of laboratory furniture that is available. The company offer a consultative service in connection with laboratory services and furnishing problems and in this connection their qualified technical and design staff co-operate with both architect and client.

F. Darton & Co. Ltd. (Stand No. 29).
Temperature and pressure recorders—portable and inexpensive instruments which need no installation—will be shown on this stand, together with mercurial barometers, brass-cased aneroid barometers, hygrometers of various sizes and types, meteorological thermometers, rain gauges, manometer single tube type (precision) and a test bench barometer reading to infinite altitude.

An item which will be exhibited for the first time will be a precision manometer for pressure, vacuum or differential pressures.

Other items to be seen on this stand will be a hair hygrometer for works and factories with 8 in. dial (this also indicates the air temperature on a subsidiary scale) and temperature and humidity recorders showing rate of change on graphed chart paper.

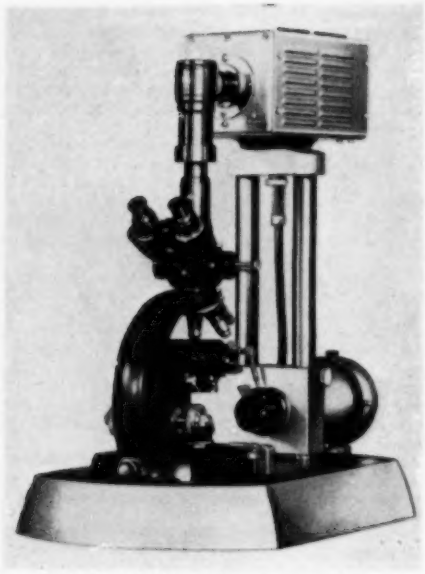
Degenhardt & Co. Ltd. (Stand No. 54).
The new Zeiss Siemens television microscope will be shown on this stand for the first time in this country. This equipment is used in the microscopic examination of radioactive material and of material subjected to radioactivity and for all other investigations endangering the observer and for microscopic determinations during which the observers should not enter the room in which the microscope is located and in which infectious material or material subject to infection is handled. It can also be used for examinations in invisible light and for examinations on objects with insufficient image contrast.

Other items on this stand will include the Carl Zeiss range of stereo microscopes, operation microscopes and photomicroscopes together with Colora thermostats and viscosimeters.

Electrothermal Engineering Ltd. (Stand No. 35).
A comprehensive range of Electrothermal laboratory heating equipment for flasks, funnels, beakers, etc., together with distillation and extraction apparatus, Kjeldahl and Micro Kjeldahl apparatus and electric bunsens will be shown and also four recently introduced items of equipment: the electric melting point apparatus, glass tube cutter, precision brazing equipment and immersion heaters.

The full range of surface heaters for temperatures from

Elgastat glass washer.



Zeiss television microscope on the Degenhardt stand.

100°C. to 1,000°C. including pipe heaters, heating tapes, Heat-by-the-Yard, Thermocord, armoured heaters and flexible furnace together with the industrial heating tapes recently introduced for attaining temperatures up to 1,000°C. will also be on show.

New additions to the Electrothermal range of laboratory apparatus to be exhibited will be the electronic thermometers for medical use, electronic diagnosis apparatus and electronic measuring instruments for laboratories operating by contact and by infra-red without contact.

Elga Products Limited (Stand No. 1).
The company's Development Section will introduce:

(*a*) *Mixed Bed Deionizer for the Semiconductor Laboratory.*—The unit consists essentially of a mixed bed Elgalite column, a storage tank, and a recirculating pump. After passage of the crude water through the mixed bed column this is guided through an 0.45 micron filter in series with an activated charcoal bed. From this the deionized and filtered water passes through a UV radiation unit and is then finally collected in a sealed receptacle. The water is not run to waste; it is recirculated, for economy.

This unit provides the Semiconductor Laboratory with a self-contained pilot plant for the assessment of process requirements.

(*b*) *The Elgastat Glass Washer.*—This deionizer is based on the Elgastat transistor washer and adapted to fulfil the following function: In hard water areas, laboratory glassware has to be dried after cleaning in order to avoid deposits. The use of deionized water prevents deposits forming, and thereby saves the necessity of drying. This fact has been recognized for many years but for reasons of economy the process did not always prove acceptable. This glass washer overcomes this objection by recirculating the effluent, with resultant economy.

Other exhibits will cover a range of deionizers for the preparation of ultra pure water in academic and industrial research.

A section of the stand will be devoted to demonstrations of deionizers and conductivity meters for school laboratories and Technical Colleges.

Elliott Brothers (London) Ltd. (Stand No. 18).
Included in the exhibits to be shown by the Microwave & Electronic Instrument Division will be:

Microwave instruments and components for frequencies above 6,000 Mc/s.

A semi-automatic microwave reflectometer for rapid measurements of v.s.w.r.

Transistorized stabilized low voltage d.c. supplies for use from a.c. mains.

Transistor inverters and converters.

Precision frequency decades covering various ranges from zero to 30,000 Mc/s.

Accessory units for recording and visual display and equipment to enable klystrons or carcinotron oscillators to be phase locked to a 100 Kc/s crystal standard having an accuracy of two parts in 10^8.

High gain and special purpose audio frequency amplifiers.

A range of electronic sub-units, together with a novel method of assembly to provide a variety of different applications.

The Electrical Measuring Division will be showing the '230' recorder, the '5,000' portable a.c. test set, a reflecting dynamometer and examples of the new rectangular meters.

Elliott Brothers complete analytical bench.

Endecotts (Filters) Ltd. (Stand No. 45).
Test sieves to B.S. and U.S. Standards manufactured completely from stainless steel will be shown as well as test sieves to B.S.410:43 which are manufactured under licence from the British Standards Institution, U.S. Sieve Series (ASTM E.11:39) and of other international standards, also pocket 'Interchanger' sieves and various sieving ancillaries.

The rapid separation of particles will be demonstrated with transparent rimmed test sieves on an 'Endrock' test sieve shaker. Visitors will see a mixture of coloured material inserted in the top of a nest of sieves; in approximately 30 seconds it is graded into six different sizes each size of which is a distinctive colour.

This test sieve shaker is normally powered by a fractional horse-power single phase motor to work off 230-240 volts or 200-220 volts, 50 cycles and incorporated in the circuit is a time-switch which can be pre-set for tests of any duration between 0 and 60 minutes.

Esavian Ltd. (Stand No. 19).
Examples of quality built laboratory furniture, scientifically designed for modern requirements, will be displayed. These Unilab units will fit compactly into any laboratory, whatever its shape or size. The units are quick and easy to instal, built in beech or mahogany, with a wide choice of tops, including Moulmein Teak, Iroko, Formica and stainless steel. They provide unlimited scope for every type of laboratory work.

The company also offer a complete laboratory furnishing contract service, including fume extraction, plumbing and all bench fittings.

Esco (Rubber) Ltd. (Stand No. 2).
The following products will be exhibited by this company:

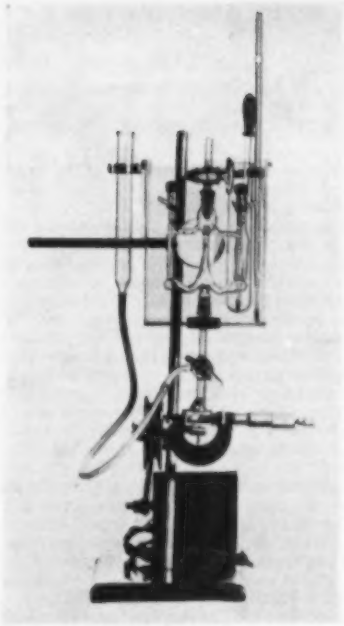
Rubber, silicone rubber and plastic products, including E.R.L. rubber test tube holders, E.R.P. waterclear non-toxic plastic tubing sterilizable at 120°C. and made in sizes from 0.5 mm. to 40 mm. i.d., Escorubber silicone rubber tubing, quality TC156, non-toxic and suitable for a wide range of extreme temperatures, Escorubber rubber and silicone rubber bungs in 60 sizes, E.R.L. extra heavy rubber pipette teats in seven colours for identification purposes, E.R.L. rubber filtering cones for Buchner flasks, E.R.L. silicone rubber covered magnets for magnetic stirring, rubber and silicone rubber liners for bottle caps, E.R.L./52 rubber closures for large containers in long storage, and special mouldings to customers' specifications.

W. G. Flaig & Sons, Ltd. (Stand No. 26).
A full range of all glass Exelo stopcocks, including several new types will be shown. Its base is a moulded body, the surface of which is an optical flat with two holes in it, connecting up to two tubes which are fused to opposite sides. The key is a similarly moulded part with one surface optically ground and having a curved channel which connects the flow through the tube when positioned correctly. The two parts are held together by means of a nylon screw which passes through holes in the centre. Stainless steel screws are available as an alternative. The hexagonal design of the key makes it easy to operate and control. The high degree of accuracy of the ground surfaces ensures that there is no leakage and in fact makes it possible for this stopcock to be used for many purposes without lubricant.

A full range of apparatus fitted with these stopcocks is to be exhibited, including burettes, separating funnels and Orsat apparatus.

A new range of volumetric glassware with permanently filled graduations will also be shown. These graduations remain permanently legible when in use in the laboratory. An improved design of measuring flask will also be exhibited. This flask is a wide necked shorter form than the usual design and offers obvious advantages in use.

The Exelo Safety Pipette, including the new type fitted with a stopcock, eliminates the need for mouth suction. The liquid is raised into the pipettes by means of the Exelo pumping device which is also used in the Exelo automatic burettes.



Scholander apparatus on the Flaig Stand.

The Scholander micro gas analyser was designed for the accurate determination of carbon dioxide and oxygen in small samples of respiratory gases. It handles ½ ml. to 1½ ml. samples of 0-99 per cent absorbable gases at the rate of three to four analyses per hour.

In the Exelo Scholander micro gas analyser exhibited the original design has been improved by incorporating taps of a registered design in the absorbent reservoirs, and by using a new low-friction polymer for fabricating mercury tight washers.

Basically similar to the Pregl apparatus with its many modifications, the Markham steam distillation apparatus to be exhibited achieves compactness by replacing the usual vacuum jacket with a combined steam jacket and trap.

Other equipment to be shown will include Orsat apparatus, a vacuum desiccator with improved design of stopcock, a free piston burette and a horizontal type pipette, designed to allow rapid repetition dispensing of different quantities of liquid.

Flatters & Garnett Ltd. (Stand No. 4).
This company will be demonstrating a range of microscopical and biological equipment with particular emphasis on microprojection.

The No. 1 microprojector, in its latest version, provides a versatile piece of equipment in teaching and research laboratories as it can be readily adapted to show prepared slides at a wide range of magnifications as well as living specimens. Slides can be shown by polarized light and attachments are also available enabling small scale experiments to be demonstrated. The projector provides an ideal method of quickly preparing drawings at any desired magnification.

The 'Mikrops' industrial microprojector is now being used in an increasing number of industries where it can largely replace the microscope for the routine examination of microscopic structures. This instrument is designed with the

convenience of the user always in mind and is exceptionally simple to operate. A wide range of magnifications can be provided up to X2,000.

In addition to the above, a selection of equipment used in the study and teaching of biology will be shown, including stains and reagents for microscopy, microscopical preparations, colour slides for projection, entomological equipment, etc.

T. Gerrard & Co. Ltd. (Stand No. 34).
Examples of the following will be shown:

Zoology.—The preparation and supply of zoological dissections and injections, material for dissection. The mounting of specimens and life cycles. The preparation and mounting of entire specimens from Protozoa to Chordata Vertebrata, the preparation of culture material, cartilagenous skeletons, demonstration mounts. The preparation of embryological material and pathological material and its mounting, the disarticulation and mounting of invertebrate specimens, the supply of aquarium and vivarium material.

Botany.—The preparation and mounting of botanical specimens, germination stages, life cycles, type collections of the various plant groups. The supply of Herbarium specimens, material for systematic work, living plants and material seeds for germination.

Models.—The modelling, casting, fabricating, and painting of zoological, botanical, plant and animal histology, embryology, anatomy, mid-wifery, bacteriology, hygiene, first aid, comparative anatomy and cytology, entomology, pestology.

Osteology.—The preparation, articulation, disarticulation and mounting of skulls and skeletons for the study of anatomy and physiology and comparative anatomy.

Microscopy (Microbiology).—The preparation and making of microscopical slides by various micro-techniques.

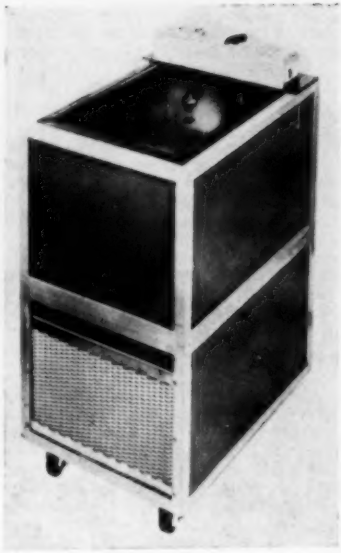
Charts and diagrams.—The drawing and making and supplying of charts and diagrams in biology, osteology, anatomy and physiology, hygiene, nutrition, health and sex education, entomology and the supply of film strips, transparencies, books and other publications.

Apparatus.—Biological and physiological apparatus, dissecting instruments, lenses, bench and microscope lamps, micro-projectors, microscopes and allied apparatus, physics apparatus collecting apparatus, laboratory glassware, plastic laboratory ware, botanical and entomological equipment.

Chemicals.—Microbiological staining solutions, biological test reagents, bacteriological culture media, culture solutions, mounting, clearing, embedding, dehydrating agents, histological and cytological fixatives, enzymes and glandular extracts, injection media, biological test and analysis outfits, laboratory chemicals, indicators, and test outfits.

Grant Instruments (Cambridge) Ltd. (Stand No. 56).
In addition to their standard laboratory water bath, in four different sizes, the company will be exhibiting two pieces of equipment for the first time. The low temperature bath has a range of —25°C. to + 65°C. ± 0.5°C. with all the features of the standard bath (stainless steel tank, propeller stirring, direct-setting dial, etc.) and costs £97 10s. 0d. A stainless steel heat extractor is built into the bottom of the tank (which measures 18 in. × 12 in. × 9 in.) so that the very efficient cooling is obtained without pipes or coils to obstruct the clear working space inside the bath. The bath is heavily insulated, and mounted in the upper half of a trolley, with the refrigeration equipment in the lower half.

Also exhibited for the first time is a clip-on thermostatic control unit containing the same components as the standard bath, enabling virtually any vessel to be used as a thermostatic bath. This was originally produced to overcome the high transport and import duty costs involved in exporting complete baths, but is now in considerable demand in this country as well. In basic form it costs £19. 10s. 0d. but the model can also be fitted with the pump circulator available as an extra on both baths and control units at a cost of £3.



Grant Instrument's low temperature thermostatic bath.

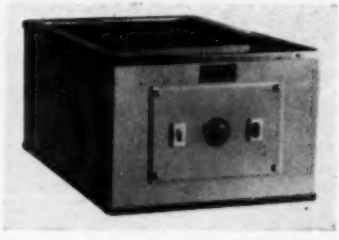
This enables the control unit to provide a pumped supply of water at a constant temperature, which can be used for circulating round water jackets or other apparatus. Output is 3½ litres a minute at no head.

Charles Hearson & Co. Ltd. (Stand No. 21).
Included in the exhibits on this stand will be:

General Purpose Water Bath.—This new water bath has been designed to meet the requirements of users in a wide and varying field—industry, education and medicine. The working space is 18 in. × 12 in. × 7½ in. deep and the liner is manufactured from a corrosion resistant stainless steel with matt satin finish. Effective temperature range is from room temperature to 100°C. and incorporation of the new Hearson hydraulic thermostat ensures accuracy within ± 0.5°C.

Quadrate Oven and Incubator.—The Quadrate combined oven and incubator is eminently suited to industrial and educational laboratories where, by means of a simple 'two-switching' arrangement, the same piece of equipment can be used either as an incubator for temperatures up to 60°C. or an oven up to 200°C. the thermostat control giving an accuracy ± 0.75°C. The working space is 12 in. wide, 12 in. deep, 11½ in. high and two removable wire grid shelves are included.

Prothrombin Bath.—This glass-sided bath has been designed for the Prothrombin test, but at the same time can be used in many other laboratory applications. It is electrically heated with the Hearson capsule control, and artificial lighting is provided in the form of a lamp which slides, in its housing, along the top edge of the bath. The bath will take



Hearson water bath.

two standard racks for Wassermann, Kahn or agglutination tubes. Internal working space 11¾ in. × 8½ in. × 5¼ in. deep. The temperature range covered by any capsule is approximately 8°C. and overall temperature variation is ± 0.5°C.

Slide Drying Hot Plates.—These hot plates are primarily for microscope slide drying and the variable thermostat offers a choice of temperature within a range of 20°C. from a predetermined setting, with a working tolerance of ± 1°C.

Laboratory Furniture.—The laboratory bench and stools on display are examples of the company's manufacture.

Incubators.—Models to be exhibited are a few of the large range now available with either a wood or metal outer carcass, both anhydric and water-jacketed. These incubators are designed to operate from a few degrees above ambient up to 60°C. and control is either by capsule of thermostat to within ± 0.5°C. The company also specialize in the design and manufacture of temperature-controlled rooms with or without humidity control, also cold rooms. In addition to supplying biological incubators, they produce an incubator for premature infants, with full provision of safety devices and also poultry incubators heated by either oil or electricity with an egg capacity of from 50 eggs upwards.

Drying Ovens.—A new oven will be exhibited, with working space 15 in. × 15 in. × 18 in. high giving a performance superior to that shown in BS.2648:1955. This oven is for use up to 200°C.

Also to be shown will be a range of scientific glassware, and of equipment for educational requirements.

Hendrey Relays Ltd. (Stand No. 42).

Among the items to be featured by this company will be automatic tissue processing machines and associated equipment; single channel spark recorders type 1487A; mercury vapour concentration meters; mains failure contactors; rotary switches; hand electro-magnets types B.216 and B.221; duration switches type C.4433; and a.c. adjustable timers.

A new piece of equipment is the earth circuit test set which can be used by unskilled persons to test under overload conditions the continuity and current carrying capacity of the earth circuit.

F. J. Hone & Co. Ltd. (Stand No. 17).

A variety of laboratory equipment for testing petroleum based products to I.P. and A.S.T.M. standards will be exhibited.

The following specialist apparatus will also be exhibited.

(*a*) The BP-Hone automatic distillation apparatus which provides a rapid method for the routine testing of refinery products when the value of a single point on the distillation curve gives sufficient information for day-to-day volatility control.

(*b*) Stainless steel fine control needle valves and gas sampling bombs tested to 4,000 p.s.i., and designed to meet the special requirements of the petroleum and petro-chemical industries.

V. A. Howe & Co. Ltd. (Stand No. 48).

The emphasis on this stand will be on automation and laboratory labour-saving devices, and as it is felt that this exhibition is an ideal opportunity for letting research workers and technicians in this country see something of what is being produced in this field by oversea firms, a wide selection of instruments of U.S. and Continental manufacture is being assembled for showing.

The nearest to an ordinary day-to-day laboratory line that the company will show is the Helios range of drying ovens, made in Sweden, and which is being introduced to this market for the first time.

Laboratory pH instruments are by no means unique, but because the Danish firm of Radiometer has had an insignificant home market for its products, it has had to complete on a world wide scale.

A representative range of these instruments will be shown, but especial mention must be made of their PHM4 meter, the Titrator TTT1, and the new Titrigraph SBR2/SBU1, which has a wide field of application in pH and buffering study and in enzymatic and protein investigations, or any other studies requiring maintenance of constant pH in reaction solutions.

Hone automatic distillation apparatus.

RC-2 automatic superspeed refrigerated centrifuge.

An entirely new instrument is an ultra-violet flow analyzer made by the Canal Industrial Corporation for the automatic location and measurement of ultra-violet absorbing materials in flow. Another instrument of especial interest will be a fermentor drive assembly representing the range of fermenting equipment made by the New Brunswick Scientific Co. The latter is also sending for this exhibition some gyratory shakers and an electronic bacteriological colony counter.

The range of outstanding laboratory equipment manufactured by Ivan Servall Inc. of Newark, New Jersey, will be represented by their RC-2 automatic superspeed refrigerated centrifuge, together with a Szent-Gyorgyi continuous flow system, and a Porter-Bium microtome.

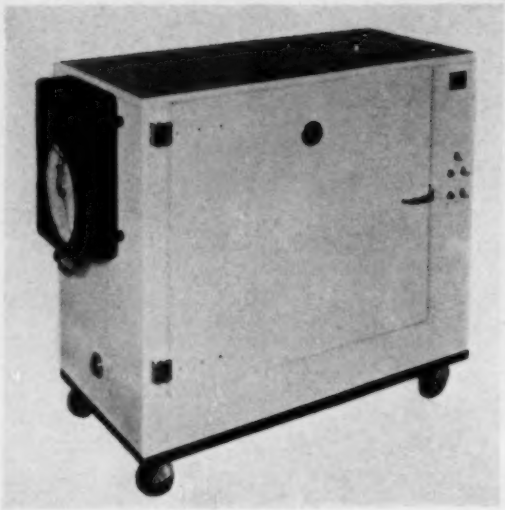
It is also hoped to have available in time for this exhibition a model of the new Misco remote pipetting burette; another item that will most certainly be shown is an Eppendorf flamephotometer which has been described as 'the biggest advance in flamephotometric instruments in ten years'.

A range of equipment that will attract considerable attention is the range of Virtis freeze drying equipment which is now being introduced to this market, and for which many enquiries have already been received.

Apart from the above, the company will also exhibit Peristaltic pumps, a new colorimeter, various items in the chromotographic field and an inexpensive fraction collector, together with a number of laboratory aids.

Hudes Merchandising Corporation Ltd (Stand No. 57).
Among the general laboratory apparatus to be shown on this stand will be the Sartorius-Werke electronic vacuum micro balance for use in the fields of evaporation or cathodic disintegration, differential thermo-gravimetric analyses and specific surface area determinations. It can also be used with a recorder for continuous recording of data or coupled into automatic production control technique. Other items in the Sartorius-Werke range will be a sedimentation balance and an MPR. balance.

Isomantle micro oven.



Weyco climatic cabinet.

Equipment of Martin Christ manufacture will include a super ultra centrifuge, refrigerated, high speed and small centrifuges. From Heraeus will come a full range of drying ovens, incubators and furnaces. A selection of laboratory shakers, stirrers, mixers and grinders from Janke & Kunkel, together with a new calorimeter and a new production of the Wurzschmitt bomb.

Phywe will be showing a selection of teaching equipment for colleges, and Membranfiltergesellschaft will be showing a range of membrane filters of graded porosities for use in industry or research.

Isopad Ltd. (Stand No. 15).
The company will be showing the full range of electric heating mantles from the smallest micro type to the largest pilot sizes made for flasks up to 200 litre capacity.

All equipment is also available in the special patented design suitable for flameproof areas Groups II and III.

A new appliance of the micro range is shown for the first time: a Micro oven with a cavity 4 in. in diameter and 4 in. deep giving temperatures up to 300°C. and a ventilation rate of 150 changes or 112 litres of air per hour.

Another newcomer is the Isomantle extraction unit for Kjeldahl flasks of 300-500 ml. capacity giving high heat concentration up to the 30 ml. level.

The exhibits will also include Isotapes and jackets for the heating of pipelines and columns and an interesting range of manual and automatic controls both standard and flameproof.

The latest edition of the Isomantle Laboratory Catalogue will be available which includes a full specification of Isomantles for glass plant including reaction vessels with hemispherical base.

Laboratory Equipment (London) Ltd. (Stand No. 20).
A brief description of the exhibits to be seen on this stand is as follows:

The WEYCO Automatic Climatic Cabinet.—This gives precise and accurate control of temperature and humidity and is based on creating humidity by means of atomized water instead of steam injection. This means that high humidities are obtainable at temperatures from ambient upwards, and these cabinets are essential for testing products

under normal climatic conditions. This cabinet can be fitted with refrigeration which considerably increases the versatility A cycling device can also be fitted.

The WEYCO Airflow Ovens.—This system is covered by Patent No. 812417 which is based on the positive airflow system so successfully used in the Weyco climatic cabinets. This is one of a series of hot air ovens, sterilizing and general drying ovens.

The FAC Industrial Construction System.—A set of self-contained parts which are easily assembled into a variety of working models and prototypes for experimental purposes or for performing specialized tests.

The WEYCO Low Temperature Thermostatic Bath.—A recent addition to our range, it complies with BS.757, is electrically heated and motor stirred, and controlled by means of an adjustable mercury in glass contact thermometer. Range 0-30°C. with an accuracy of ± 0·1 °C.

The WEYCO Range of Humidifiers and De-humidifiers.—Introducing a new unit—the Aerosolette. This is a portable and non-wetting humidifying unit—the complete answer to 'over dry conditions.' Can be used in offices, hospitals, florists, laboratories, etc. Capacity five and a half pints, emission approximately one pint per hour.

The WEYCO Range of Balances

The WEYCO Heavy Duty Stirrer.—This is designed to stir any liquid however thick. Torque at maximum speed is 4 lb./in. Available in several speed ranges.

L. Light & Co. Ltd. (Stand No. 50).

This company is well known for the wide range of organic compounds and bio-chemicals, as listed in their catalogue. At this exhibition they will therefore feature the lesser known sides of their business. Large colour transparencies will show the recently erected all-glass pilot plant equipment, new stores and analytical laboratory. Their latest development—ultra-pure elements for semi-conductor and solid state physics—will be represented by a display of specimens, including high purity red and white phosphorus.

The Microscale zone-melting apparatus developed in the company's own research laboratory and used for ultra-purification of costly materials will be demonstrated; specimens of scintillating substances, purified in their large zone melting devices, will also be shown.

Dreiding molecular models, now widely used for educational and lecture purposes, will be available for visitors to examine.

Brochures and samples of Permutit and cellulosic ion-exchangers, aluminas and silica gels for chromatography, Celite filter-aids, Spans and Tweens, Drierite, etc., will be displayed.

W. Markes & Co. Ltd. (Stand No. 14).

The 'Marklab' fittings to be exhibited at the exhibition are the result of some 60 years specialization in this field, and will include a comprehensive range of taps, cocks and valves for use in the modern teaching, industrial and research laboratory and hospital. The range includes taps for hot and cold water, distilled and demineralized water; cocks for vacuum, town gas, butane and bottled gases; valves for compressed air, steam and hazardous gases; and fittings of special interest to the pathological and medical research laboratory.

It will be noted very special attention has been paid to the smooth streamlined exterior of the fittings, eliminating so far as is practicable all waists, shoulders, beads and crevices which may trap corrosive substances, eventually condensing out and setting up corrosion. Further, the whole range of bench and vertical surface fixing fittings are now available with integral tail pieces and locating squares, thus eliminating the need for fixing screws in the flanges. It is usually difficult to match the fixing screw heads with the new plasticized finishes now available. The periphery and slot of such screws readily form reservoirs for spilled acids and other corrosive substances.

Particular emphasis will be placed on the new 'Markthene' polythene coated finish applicable to all fittings. This finish largely overcomes the troublesome problem of tap finishes in the laboratory, possessing all the acid and corrosion resistant properties of polythene, coupled with a truly remarkable mechanical strength and resistance to chipping and abrasion. This latter feature has proved to be the principal weakness of the otherwise excellent sprayed and stoved finishes now available, where the acid resistant properties are in direct proportion to the stoving temperature, and of course the higher the stoving temperature, the greater the brittleness of the finish. Fittings will also be available in the conventional black oxydized, chromium plated and epoxy-resin finishes.

Typical Marklab multi-service pedestal unit.

The 'Marklab' range incorporates the design and performance requirements of BS.3202, 'Laboratory Furniture & Fittings,' particular attention having been paid to service identification by means of shape or feel; colour and letter coding. All services are supplied with attractive vacuum coated Perspex discs coloured in accordance with BS.1710 requirements.

Illustrated is a typical multi-service pedestal unit. These assemblies are generally produced to customers individual requirements and may incorporate hot and cold water, various gases, compressed air, vacuum, steam and electrical services. The unit illustrated provides eight water taps, arranged to discharge into two drip wastes, to any of which may be attached water jet pumps for low vacuum requirements; four steam valves; eight gas taps and four condensate drain connections. The units may be supplied in wooden or metal construction and arranged to support reagent bottle shelves, and are supplied complete with internal pipe work and risers so that all the fixer is required to do is to make one connection for each service provided. These units are of special interest in the export markets for use with locally made furniture.

May & Baker Ltd. (Stand No. 36).

An interesting feature of this stand will be a working model demonstrating preparative gas chromatography. This technique is being used extensively in the laboratories of universities, research institutes and industry. Compared with fractional distillation, gas chromatography is highly efficient for the fractionation of mixtures. Fixed conditions of column dimensions, temperature, gas flow, pressure gradient and the nature and quality of support and stationary phase are essential. To fulfil this requirement, the M&B range of 'Embaphase' stationary phases and 'Embacel' brand Kieselguhr support mediums on display are supplied to known standards. These standards, and full information on their use are given in the M&B publication 'Materials for Gas Chromatography'.

The **Elgastat** *provides ultra-pure water*

The Elgastat provides intrinsic water instantly—H_2O of almost theoretical purity—4 megohm-cm+, without regeneration or maintenance—consistently—where you want it—when you want it—at a turn of the tap.

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If it's ion exchange ask **ELGA** *first*

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Another feature of the stand will be a collection of laboratory and analytical reagents, research chemicals organic analytical reagents and indicators from the M&B range, included in which are mineral acids, alkalis, inorganic salts and many aliphatic and aromatic organic compounds. Among their many applications are the synthesis of organic compounds and isolation of their characteristic derivatives and, in analytical work, the preparation of volumetric solutions and reagents for qualitative and gravimetric analysis.

Special packing techniques have been evolved for the transport of some of these chemicals. Three types of pack: acid van boxes, closures for volatiles and a closure for acid bottles will be demonstrated.

National Research Development Corporation (Stand No. 51). Among the items to be shown on this stand will be:

Automatic Vacuum Sampler.—This sampler was developed at the Water Pollution Research Laboratory of the Department of Scientific and Industrial Research, and is intended for taking samples at predetermined times from channels, streams and open tanks. It is self-contained and proof against moderate weather conditions. In principle, the device consists of a number of sample bottles each of which is evacuated and connected to the source from which samples are to be taken. In preparing the sampler for use the bottles can be evacuated by a hand pump or by a rotary vacuum pump, each bottle, as evacuated, being sealed off by a closure member. At the sampling station the apparatus is switched on by time-switch means provided and the device is left to take samples at the predetermined required times.

Simple Micromanipulator.—This instrument is simple and sturdy in construction and has been designed for use under the medium power microscope. It permits fine and fairly rapid movements in all three planes and allows the working point to be rotated. It is provided with means for interchanging tools and also for the use of forceps in addition to the more usual scalpels and needles. The model demonstrated shows the minute movement possible by digital operation of this instrument through the provision of grease damping arrangements. This grease damper provides sufficient friction in all planes to smooth out small involuntary movements, such as hand tremors, to negligible proportions and to overcome gravity when the forceps are held in any position. The permissible use of forceps by foot control of a pressure manipulated rubber teat operator is a feature of this apparatus and has enabled the successful operation of such procedures as de-sheathing the abdominal nerve cord connectives of the cockroach. This involves holding a tough membranous sheath clear of the underlying nerves and tearing it without stretching or jerking the delicate fibres beneath, an operation requiring great steadiness of hand. This device is by Mr. J. P. Heslop of the Pest Infestation Laboratory, Agricultural Research Council, Slough, Bucks.

Frost Point Hygrometer.—This instrument, developed at Royal Aircraft Establishment, Bedford, has a continually running refrigerator working at a temperature at least 10°C. below the minimum frost point temperature being measured. This temperature is obtained by the reaction of dry ice and alcohol, or with liquid nitrogen or liquid air. A copper slug is inserted in the refrigerator to cool by conduction a small mirror made of constantan metal which is rhodium plated. This mirror is placed in the air stream under test, in such a manner that frost deposited upon it can be observed through an optical viewer. Air under test can be drawn across the mirror with the aid of a small pump. The viewer also enables the auto control to be set up and enables the instrument to be used under manual control. The surface of the mirror which is highly polished is illuminated obliquely by a lamp and a lens system. A photocell views the mirror surface through another lens system and only detects scattered light from the surface. A second photocell is illuminated directly from a lamp through an adjustable aperture. The output from the two photocells is then compared and is used to modulate the amplitude of an oscillator. The output of the oscillator is then rectified to produce a D.C. signal which controls an R.F. eddy current heater, the output coil of which is wound directly on to a high loss bobbin surrounding the copper slug in very close proximity of the mirror assembly. Thus the temperature of the mirror is accurately controlled by the photocells at the frost point of the air under test. The temperature of the frost point is then measured by the thermo-electric effect produced by the constantan mirror and the copper slug. To avoid the mirror assembly becoming overheated when the refrigerator is short of coolant a thermal cutout makes the eddy current heater inoperative.

The North of England School Furnishing Co. Ltd. (Stand No. 43).

At this stand will be shown examples of laboratory benching and shelving, fume cupboards, and fume extraction equipment, together with a representative selection of modern bench valves and outlets.

The company's technical staff will be in attendance throughout the exhibition, and drawing and lay-outs will be available for a range of laboratory installations to suit all users, from the school and Technical College to the industrial and research organization.

Oxo Ltd. (Stand No. 44).

Here will be seen a wide range of culture media of interest to all branches of bacteriology including medicine, public health, milk and water testing, brewing and food manufacture.

Particular stress will be laid on a recently introduced service whereby laboratories all over the country can be supplied with culture media ready poured into sterile disposable plastic Petri dishes, at a very competitive price thus eliminating much of the preparatory work which used to be customary in bacteriological laboratories.

A new range of peptones and all the company's standard culture media ingredients will be displayed, together with the newly introduced British made disposable plastic Petri dish. For haematological laboratories there will be a new disposable Precipitin tube made in plastic, which has not been previously marketed in the United Kingdom.

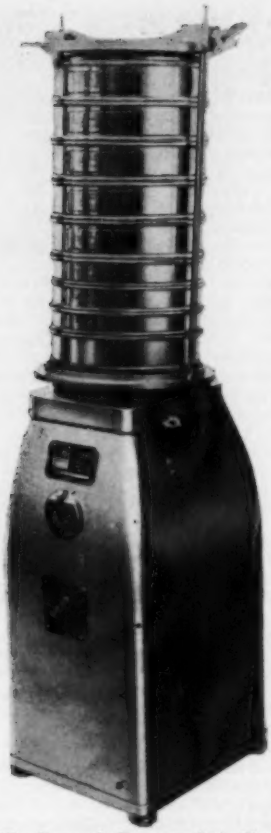
One of the main items of this display will be a demonstration of membrane filtration techniques, together with a display of the special membrane filtration culture media, put up in the form of tablets, which have been developed in the Oxoid Laboratories.

The Pascall Engineering Co. Ltd. (Stand No. 16).

The laboratory grinding, sifting, mixing, dividing and dispersing equipment made by Pascall includes ball mills, end runner mills, sample dividers, test sieves and test sieve shakers and triple roll mills.

The equipment on show will include a small bench mounting ball mill with variable speed control, a larger three-tier ball mill designed to carry a number and a variety of sizes of porcelain pots from one gallon to one pint nominal capacity, a small end runner mill suitable for dry or wet grinding small quantities of various materials, the well known 'Inclyno' test sieve shaker complete with a set of B. S. test sieves for the accurate analysis of the particle size range of materials, a new centrifugal sample divider for the division of seeds and granular materials and a triple roll mill for the dispersion of solids in media.

Pascall laboratory process equipment is already well established and units are in use in the laboratories of the Admiralty, Atomic Energy Authority, British Transport Commission, Central Electricity Authority, Ministry of Supply and National Coal Board and other industries such as the aircraft, automobile, chemical, cosmetic, electrical, food, mining, pharmaceutical, plastics, paints and printing inks, in fact, in every industry in which the processes of grinding, sifting, mixing, dividing and dispersing are involved.



The Inclyno test sieve shaker complete with set of B.S. test sieves.

The Permutit Company Ltd. (Stand No. 22).
This stand will feature a display of portable Deminrolit units and ion exchange resins.

In addition to the already well-known Marks 4 and 5 portable Deminrolit's, which convert any clean water simply into very pure demineralized water, there will be the new Mark 6 portable Deminrolit. This is a mixed bed ion exchange unit, capable of producing demineralized water having a purity of less than 1.0 micromhos. Portable Deminrolit units are easily regenerated, and can produce up to 12 gallons hourly of very pure water. They are easy to operate and running costs are negligible. Construction is robust and employs non-corrodible materials. Portable Deminrolit units are widely used in laboratories and research departments throughout the world.

The ion exchange resins in portable Deminrolit units are manufactured in Great Britain by Permutit. They are of the Zeo-Karb and De-Acidite types. Permutit will display a wide range of these resins specially graded for analytical work and available in 1 lb. packets for laboratory users. Demonstration columns will also be on view to illustrate the versatility of Permutit ion exchange resins in the laboratory.

Premier Colloid Mills Ltd. (Stand No. 38).
The main exhibits on this stand will be the 3 in. H.P. mill for laboratory and small scale work, the Premier pilot mixer, standard laboratory mixer and a new seven speed heavy duty laboratory mixer. This last mixer runs at various speeds—from 6,000 r.p.m. down to 85 r.p.m.—and with dispersators, propellors and turbines, will handle any type of small mixing job likely to be found in any laboratory.

Three inch multi-purpose Premier mill.

J. Preston Ltd. (Stand No. 28).
Displayed on this stand will be a selection of instruments and apparatus including:

Furnace.—The 'Minifurnace' is a small but efficient muffle furnace with a maximum temperature of 1,200°C. and built in temperature indicator and control. An electrically controlled muffle furnace operated by its own transistorized temperature controller.

Thermostatic.—The 'Ultra' Type K thermobath has been developed for connection to equipment requiring fluid circulation at a constant temperature.

Epi-Technoscope.—This stereoscopic microscope by Carl Zeiss has many unique features. This company are now stockists of Zeiss equipment for the North of England.

Centrifuges.—The latest equipment by Measuring & Scientific Equipment will be on show.

Heating Mantles.—A variety of the latest developments by Electrothermal Engineering in the field of heating equipment.

Balances.—Single pan balances by Oertling and Stanton will be available for carrying out trial weighings.

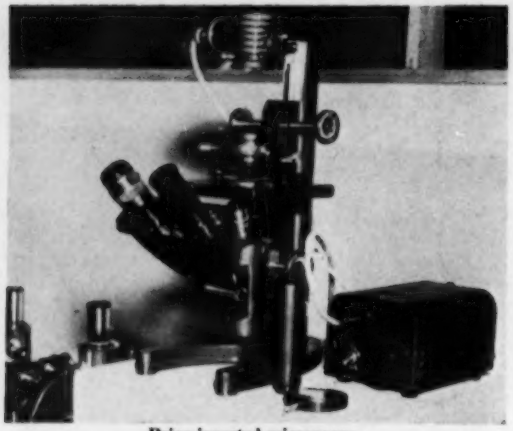
Deionizer.—The Elgastat portable deionizer is being used increasingly for the production of chemically pure water for analysis and research.

Also on display will be a selection of laboratory and scientific glassware, including work by the company's own glassblowing department, together with polythene, porcelain, rubber and silica ware.

W. R. Prior & Co. Ltd. (Stand No. 3).
The following is a brief description of the exhibits to be shown on this stand:

Universal Research Microscope.—This new model has a limb and base of slightly heavier proportions ensuring perfect stability and rigidity while in use. It is available with a flat-topped square mechanical stage or an improved rotating stage and the substage can be fitted with quick release slides for various types of condensers. The mirror is interchangeable with a compact substage light source. All the usual accessories are available.

Micromanipulator.—This instrument is provided with coarse and fine vertical movements, the fine adjustment



Prior inverted microscope.

reading to 0.005 in. for each complete rotation of the milled control. Two-way horizontal movements forward 29 mm. transverse 64 mm. with vernier reading to 0.01 mm. Left or right hand controls are available.

Inverted Microscope.—This unique instrument with special uses in cell biology, marine and freshwater biology and tissue culture has been improved and re-designed to give greater rigidity to the condenser unit. A built-in light source or an external high intensity lamp can be used if desired. Monocular or binocular heads are available. A long working distance condenser can be fitted making the instrument suitable for examination of standard size culture bottles.

Metallurgical Microscope.—A recent addition to the Prior range, this stand is of the D.S.F. and R.P.D. Models, fitted with racking stage which has a removable centre disc. The illuminating system is built-in to the body tube and has two iris diaphragms and a carefully designed condenser system. Light source is a pre-centred bulb rated at 6 volts-1 amp. Objectives are corrected for uncovered objects and all lenses have coated surfaces. The whole outfit is finished in the new polychromatic grey enamel.

Stereoscopic Microscopes.—A new range of low power microscopes designed for interchangeable units with a range of models to meet individual requirements. Binocular bodies with vertical or inclined eyetubes are available. The optical units have been specially computed for use with these instruments and the range of magnification is from ×4 to ×200, the whole range being parfocal. There are two nosepieces available, one for single objectives which can be easily changed with other powers and a triple changer which operates as a forward/backward sliding principle and which gives complete freedom for dissecting operations and manipulations. Powers can be interchanged from a selection of six powers.

Binocular Attachments.—It is often most convenient quickly to convert a standard monocular microscope to binocular vision. With this in view is presented an attachment that is adaptable to all monocular microscopes. Adaptors can be supplied for other makes.

Improved Laboratory Microscopes.—This range of teaching and laboratory microscopes constitutes a class of instruments of modern design, fitted with fixed focusing or rack and pinion substages and which can be relied upon wherever rigorous hard wear is expected.

I.C.R.F. Cinemicroscope Mk. II.—This is a self-contained transportable cinemicroscope for recording by continuous or by time-lapse 16 mm. cinephotography movements or growth in any type of microscopical specimen. It is designed primarily for studies of living cells in controlled enviroments, and provision is made for accurate control of the temperature of the specimen.

The Publishers Association (Stand No. 63).

Among the members of this Association who will be showing books on this stand will be:

Addison-Wesley Publishing Co.

Blackwell Scientific Publications Ltd. (Tools of Biological Research, Lecture Notes on the Use of the Microscope, Microchemical Methods for Blood Analysis, Laboratory Manual on Abnormal Haemoglobins, Manual of Clinical Laboratory Methods, Microtechniques of Clinical Chemistry for the Routine Laboratory, Diagnostic Radio-Isotopes, Chemical Micromethods in Clinical Medicine).

Butterworth's Scientific Publications.

Cambridge University Press. (Safety Techniques for Radioactive Tracers, Experimental Design and its Statistical Basis, Cambridge Elementary Statistical Tables, Formulating X-ray Techniques, Anticomposition Tables for Carbon Compounds, A Laboratory Manual of Qualitative Organic Analysis, The Characterization of Organic Compounds, The Estimation of Organic Compounds, The Manometric Method as applied to the Measurement of Cell Respiration and other Processes, Microscopic Histochemistry, Microscopical Techniques for Zoologists, Plant Virus Serology, Vibration Analysis Tables, A Manual of Vacuum Practice, etc.).

W. & R. Chambers Ltd.

Chapman & Hall Ltd.

Hafner Publishing Co., Ltd.

Hilger & Watts Ltd.

Charles Griffin & Co., Ltd.

Leonard Hill (Books) Ltd. (A Practical Manual of Medical and Biological Staining Techniques, Methods of Analytical Histology and Histo-Chemistry, Encyclopaedia of Microscopic Stains).

Iliffe & Sons Ltd. (Abacs or Nomograms, Laplace Transforms for Electrical Engineers, Electronic Computers, Radio Data Charts, Microwave Data Tables, Numerical Methods for High Speed Computers, The Oscilloscope at Work, Radio Designer's Handbook).

Interscience Publishers Ltd.

Crosby Lockwood & Son Ltd.

John Murray (Publishers) Ltd. (Safeguards in the Laboratory, Low Voltage Supply in School Science Laboratories, Report of the Sub-Committee on Laboratory Technicians, 1955, The Provision and Maintenance of Laboratories in Grammar Schools).

George Newnes Ltd.

Sir Isaac Pitman & Sons Ltd. (Principles of Servomechanisms, Experimental Radio Engineering, Modern Electronic Components, Electronic Equipment Reliability, Principles of Electronic Instruments and Instrumentation).

D. Van Nostrand Co., Ltd.

H. F. & G. Witherby Ltd. (Preservation of Natural History Specimens).

R. & L. Enterprises Ltd. (Stand No. 9).

This exhibit will be divided into sections covering the various aspects of the company's range of laboratory metal ware:

A full range of gas burners including bunsen, teclu, by-pass, micro, air injected blast burners and glassblowing lamps for use with towns gas and a wide range of similar burners for use with various bottled gases. Special mention may be made of the blast burner coupled with combustion units to be shown for the first time.

Laboratory supports of various types including Rexaloy clamps and bossheads, the beaker clamp with a jaw capacity of 7 in. which will support a 5 litre beaker without difficulty, the reaction vessel clamp designed for use with the Quickfit and Quartz flange neck reaction vessels and various modifications of this range. A range of retort stands, tripods, rings, etc., will be featured. A new burette holder based on principles rather different from any on the market will be shown for the first time as will a full range of micro and semi-micro stands, bossheads and clamps which are constructed in stainless steel and non-corrodible alloys throughout.

Rediweld special dispersing unit.

A section will be devoted to the range of Uniframe laboratory scaffolding with all the additional attachments included.

Rediweld Ltd. (Stand No. 58).
Featured on this stand will be:

Polythene Laboratory Ware.—Moulded beakers, funnels, measuring cylinders, etc.

Pumps and Syphons.—Constructed from polythene and/or P.V.C.—suitable for transfer of acids and alkalis from carboys and storage tanks.

Safety Buckets.—Constructed from polythene and fitted with P.V.C. handles—for carrying corrosive liquids.

Fume Extraction Fan.—Casing and rotor moulded in polythene.

Special Dispensing Unit.—For automatic delivery of liquid from aspirator.

Fume Cupboard.—Constructed mainly from rigid P.V.C. with Perspex windows and mounted on a conventional timber unit.

Ridsdale & Co., Ltd. (Stand No. 6).
Stand No. 6 will be a joint exhibit by Ridsdale & Co. Ltd., and their associates Bureau of Analysed Samples Ltd. Both these companies specialize in products for analytical laboratories, chiefly in the metallurgical field.

Ridsdale & Co. Ltd. supply a range of some 70 compressed chemical reagents for metallurgical analysis. These reagents are primarily manufactured for use with the Analoid system of analysis and will be displayed in groups showing the tablets which are used in a number of typical methods. The range of Analoid preparations includes oxidizing and reducing agents, indicators and complex forming reagents for colorimetric analysis. New additions which will be shown are sodium lithium fluoride tablets for the fluorimetric determination of uranium, arsenite nitrite tablets for the volumetric determination of manganese, and indicator tablets for E.D.T.A. titrations.

Bureau of Analysed Samples Ltd. will exhibit a variety of analytically standardized samples representative of their range of British chemical and spectrographic standards. Also included will be a number of samples which are specially prepared for students practising metallurgical analysis. The British chemical standard samples displayed will include carbon and alloy steels, cast irons, ferro-alloys, non-ferrous alloys, ores, slags and refractory materials. New samples included in the exhibit will be a 0.4 per cent carbon free cutting steel to B.S. 970 En 8 M, a 13 per cent manganese steel, a 75 per cent ferro-silicon, a 6 per cent zinc aluminium alloy to Specification D.T.D. 687A, and two British iron ores and a sample of sinter.

Four series of spectrographic standards will be shown and these include a new series of plain carbon steels, which have been analysed for C, Si, S, P, Mn and As, in the form of discs for use with vacuum spectrographs and a set of five cast iron samples standardized for magnesium and nickel which are the latest addition to the spectrographic standards issued by Bureau of Analysed Samples Ltd.

Literature giving the fullest information regarding Analoid preparations and standard samples will be available.

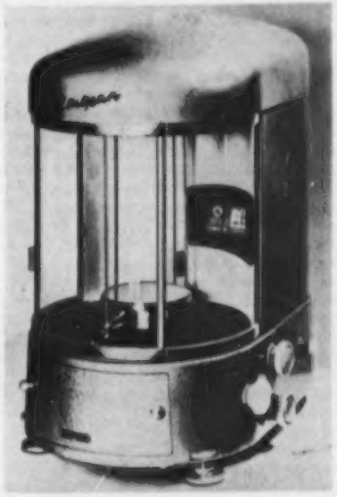
Scientific Supplies Co., Ltd. (Stand No. 49).
A range of general laboratory apparatus will be shown but special emphasis is laid on Quickfit and E-Mil apparatus and the company's well-known 'Off the Shelf' service for these products.

Recent additions to the Quickfit range such as assemblages, the Leurquin semi-micro nitrogen determination apparatus and a new vacuum receiver adapter can be seen.

Newer items in the E-Mil range will include burettes with the new plastic stopcock, safety pipettes and ultra micro pipettes.

A typical bench assembly of the 'SS' range of unit fittings will be on view together with coloured tap heads for service identification.

Other items will be a newly designed hydrolyzing bath, the improved 'SS' range of retort stands and burners, the redesigned bench blow-pipe, L.T.E. ovens, Tempunit bath heater, a new constant level device which can also be used as a vacuum pump, and a gelation timer.



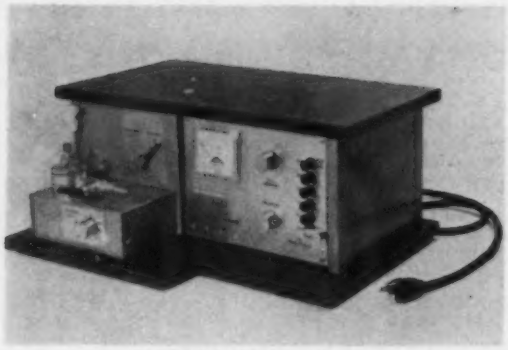
Sauter Monopan substitution balance.

Shandon Scientific Co. Ltd. (Stand No. 33).
Shandon's display will include instruments in the medical, chemical, biochemical and general laboratory fields, and will show for the first time a selection of products of the Fisher Scientific Company of America, the largest suppliers of laboratory equipment in the world, for whom Shandon are now authorized U.K. distributors.

The Fisher products exhibited will include:

1. *Fisher Clinical Gas Partitioner.*—This is the first commercial application of gas chromatography to the rapid analysis of clinical gases.

2. *Fisher Model 25 Gas Partitioner.*—The Model 25 is a



Fisher clinical gas partitioner.

battery-operated portable gas chromatograph designed for the rapid analysis of permanent gases.

3. *Fisher 'Duo-Spectranal' Laboratory Spectroscope.*—The 'Duo-Spectranal' is an inexpensive apparatus for rapid qualitative and semi-quantitative analyses of many elements. It has a wide variety of applications in many different fields—finding trace metals in soils, water or plant and body tissues; locating sources of stream pollution; rough-assaying of ores and minerals, identifying alloys, running quality controls on raw materials, pharmaceutical products, etc. It is ideal for teaching the principles of spectroanalysis.

4. *Fisher Chemical Zone Refiner.*—For the automatic purification of chemicals. The zone refiner is faster and easier than conventional refining methods and will purify most organic and inorganic chemicals that melt between 50°C. and 300°C. The action is entirely automatic and all impurities are removed together.

The display will also include many other specialized Fisher instruments for applications in many different fields.

Among a range of instruments from Metrohm of Switzerland will be the Potentiograph, a revolutionary new universal automatic recorder for all potentiometric, pH, Redox, precipitation and other complex titrations; the Polarecord, a fully-stabilized, completely line-operated instrument for both conventional and rapid polarography, amperometric or potentiometric measurements and titrations with low resistance electrodes; a range of precision pH meters, and examples of electrodes meeting the high specifications necessary for blood pH work.

In the purely medical field will be a range of Kipp products, including the CC-Oximeter, a new application of reflexion oximetry which gives direct readings of oxygen saturation at the catheter tip during heart catheterization, with a time lag of only 15-20 seconds and with a reproducibility better than ± 1 per cent; the Brinkmann Haemoreflector; the 'Microva', a super-sensitive multi-range ammeter, and the 'Micrograph', a super-sensitive multi-range recorder which can handle very high external resistances.

The comprehensive display of balances, ranging from a microgram balance to fully automatic scales of 30 kg. or more, will include many new models, among them the wide range of inexpensive 'Ohaus' double- and triple-beam sliding weight balances. Among the range of Sauter models will be the well-established 722 precision balance, the infra-red moisture balance, the fully automatic scales and an entirely new constant load substitution balance for analytical weighings, known as the 'Monopan'.

Also on display will be an example of Sauter's new range of fully-automatic print-out scales (up to 1,000 kg.) which have many applications in science and in industry for quality control, checking of weighing and packing machinery, recording of mixture constituents, etc.

Another new balance on show will be the Cahn Electrobalance which will weigh to an accuracy of 1 microgram.

The comprehensive display of Reichert microscopes will show instruments for every purpose in routine or research work.

Shandon will also be exhibiting their latest gas chromatography apparatus, which offers a choice of three interchangeable detectors, and a range of Shandon paper chromatography and electrophoresis equipments, including several new pieces of apparatus.

In addition to general laboratory equipment, the company will show the 'Filamatic' automatic vial filler. The Model AB to be displayed has a capacity of 0.025 c.c. to 50 c.c. the speed being variable between 6 and 90 fills/min. Larger models up to 520 c.c. capacity are also available and there is a wide range of accessories available to increase the versatility and usefulness of the machines. Representative examples of the newly-introduced Jumo-Shandon contact thermometers will also be shown.

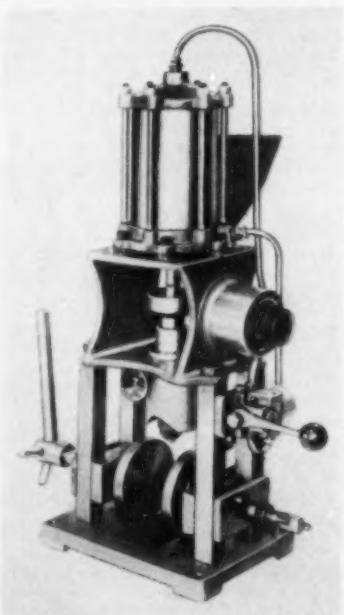
The Waring blendor, also among the new instruments to be shown, is a finely-made machine capable of rapid and efficient blending of quantities up to 1 gallon.

Silverson Machines (Sales) Ltd. (Stand No. 46).

A smaller model, designed for laboratory use, of high speed mixer emulsifier will be shown. This is not just another laboratory stirrer. It is a facsimile, on a laboratory scale, of the larger machines and all of their present modifications. It has a capacity ranging from 8 fl. oz. to 2 gal., according to the viscosity, at variable speeds up to 8,000 r.p.m.

Normal mixing and emulsification are carried out by the standard and axial flow heads with the mesh, as is also the fine suspension of insoluble solids. The cutting or disintegrator head will reduce solid animal or vegetable material or gums and resins to a smooth pulp or mucilage with great speed and efficiency.

In addition, the machine may be converted by the pump-head to a pump capable of delivering fluids at a rate which compares very favourably with conventional pumps of much larger size. The flow is non-positive and may, therefore, be interrupted while the machine is running, without damage to



S.P. power-operated plastic injection machine.

the motor or working parts. Thus, by inserting a tap or cock in the delivery tube, the machine may be used as a filler for small containers. Filtration at medium pressures is also possible by connecting the pump to an appropriate filter.

Together with a full range of attachments, this high speed laboratory mixer is capable of coping with any task of mixing, emulsifying, suspending, homogenizing, pulping, disintegrating and pumping likely to be encountered in the laboratory. The price, with all attachments and an adjustable bench stand is £31 10s. 0d. All working parts are constructed of stainless steel and the makers can also supply a complete range of fine quality stainless steel vessels and equipment for laboratory and factory use.

The Small Power Machine Co., Ltd. (Stand No. 40).
Plastic injection moulding machines, both hand and power operated, an air pressure machine and a hydraulic machine, complete with power pump unit will be shown on this stand.

The S.P. vertical bench plastic injection machine, operated either by hydraulic or air pressure, has a hopper which feeds the plastic by thumb pressure into the cup on top of the heated chamber. Owing to the special conception of the heater and chamber only 500 watts are needed.

Southern Instruments Ltd. (Stand No. 25).
The following items will be featured on this stand:

*K*1,000 *Cathode Ray Polarograph.*—A complete polarogram is presented every seven seconds on the long persistence 9 cm. screen of a cathode ray tube. This can either be viewed direct, or a camera attachment can be supplied for making permanent records. Unlike the waves or steps obtained in conventional polarography, the polarograms produced by the cathode ray polarograph consist of peaks, the heights of which are proportional to concentration.

*A*1650 *Manual Polarograph.*—This compact instrument is extremely easy to operate. The 'click-stop' method of voltage control by exact increments of 100 mV or 10 mV gives this polarograph a speed of operation comparable to recording polarographs and a complete polarogram of a solution containing several ions can be plotted in three or four minutes. In routine analysis this operation may only take a few seconds.

*A*1655 *Pulse Polarograph.*—This instrument has advantages over square wave polarography both in sensitivity and resolution. To obtain a normal polarogram the cell voltage is held for most of the time at a fixed value, but at a predetermined time in the life of each mercury drop it is changed by a polarizing pulse of 1/25 sec. to a value that gradually becomes more negative as time progresses. Electronic circuits measure the change in diffusion current produced by each pulse during the second half of the pulse life. Reversible and irreversible reduced ions can be detected at concentrations down to 10^{-7}M. With the derivative circuit concentrations down to 10^{-8}M can be detected.

Southern Instrument's manual polarograph.

*A*1653 *Hydrogen Generator.*—This apparatus consists of a d.c. supply and a special electrolytic cell in one compact unit. It is mainly for use in polarography for deoxygenating solutions prior to polarographic analysis.

*A*1659 *'Nilox' Apparatus for the Removal of Oxygen from Gases.*—This apparatus enables the laboratory worker to obtain a continuous stream of hydrogen, nitrogen, argon, etc., completely freed of the oxygen normally contaminating these gases as supplied in cylinders.

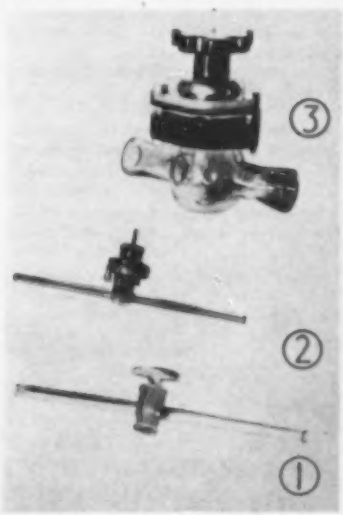
*A*1654 *Wadsworth Controlled Cathode Electrolyser.*—The use of gravimetric electrolytic analysis has been limited in the past owing to the necessity of controlling the potential manually. This disadvantage has now been overcome and once an electrolysis is started it will not be allowed to rise above a preset potential until the electrodeposition is complete. If a solution contains several metallic ions it is possible to plate them out separately by adjusting the E.M.F. so as not to exceed a predetermined value for each element in turn.

The Sigrist Photometer.—For the continuous recording of absorption and turbidity. Two beams from the same light source are directed by means of an oscillating mirror alternately to the same photocell, the measuring beam passing through the test fluid and the other beam through a comparison standard. Fluctuation of the light source, variable sensitivity of photocell and rate of amplification of photo current do not affect accuracy of measurements.

G. Springham & Co. Ltd. (Stand No. 55).
Continuous enquiries have prompted the manufacture of stopcocks and apparatus incorporating stopcocks with interchangeable keys. G. Springham & Co. Ltd., now market these under the trade name INTERKEY. The manufacturer has retained the conventional characteristics adding the overwhelming advantage of Interchangeable keys. The glass key can be purchased separately thereby relieving many frustrations experienced in laboratories using the orthodox stopcocks and apparatus. (No. 3 as illustrated).

A further development now provides for solid P.T.F.E. keys to be supplied, also interchangeable within range. P.T.F.E. keys are greaseless, inert for the majority of needs, and non 'freezing'.

The introduction of a new glass valve for laboratory use has been made. This is a greaseless high vacuum valve using a new monomer rubber diaphragm for its control. Although primarily a vacuum valve the stability of the rubber used, enables the control of many liquid phase operations to be successfully handled. (No. 2 as illustrated).



Some Springham exhibits.

For the chemist interested in glass pipe line, an example of the larger edition of the company's greaseless valve to fit up to 1 in. pipe line will be shown. It is easily cleaned, requires no grease, is non-corrosive and finite in operation. (No. 1 as illustrated).

Stanton Instruments Ltd. (Stand No. 39).
A representative selection of balances from their range will be shown.

Of pleasing appearance and robust construction, the Ultramatic balance has fully automatic weight-loading to the total capacity of 200 g. The large pan space is easily accessible while the stainless steel pan, having double suspension, does not tilt. All models allow of taring up to 100 g. and when taring, the counter mechanism clearly indicates that the taring device is in use; no subtraction is required. The controls have been grouped for easy manipulation at bench level where the coloured weight-loading dials correspond to the coloured markers on the weight-loading indicators on the front panel. The weighing result is given in one place (the last digits on the graticule screen) on the front panel so giving an ideal reading position, at once more convenient and obviating error on the part of the operator. The technique of weighing is so simple that a comparatively unskilled worker, after a short instruction period, can carry out numerous weighings speedily and efficiently. Several internal improvements have also been incorporated in the balance to ensure trouble-free operation.

The new Unimatic single pan balance will be on general view for the first time in this country. In outward appearance identical to the Ultramatic balance and incorporating all the advantageous features of that model, this new balance has been evolved to weigh on the constant load principle which has already been tried and tested in many countries.

Since its introduction a few years ago, there has been an increasing demand for the Stanton Thermo balance which comprises a standard air-damped analytical balance, a furnace mounted above, and a recording chart on which time, weight and temperature are simultaneously recorded up to 1,000°C. on the standard models, or 1,400°C. on the high temperature models, for periods up to several days. The applications of this balance in research and control works, in oxidation, reduction, metallurgical and other analytical studies are limitless.

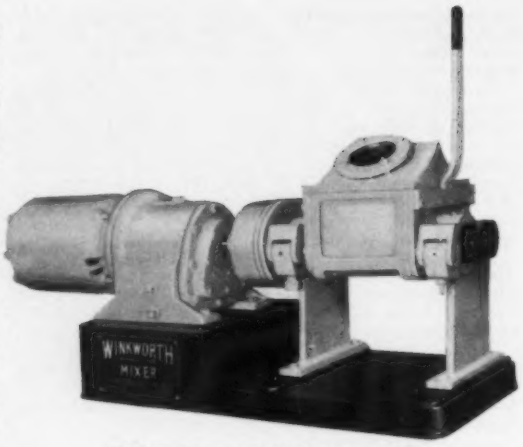
Tellus Super Vacuum Cleaner Ltd. (Stand No. 5).
Various models of suction cleaners for use in laboratories will be on display. All Tellus cleaners are canister type cleaners so they are suitable for collection of all kinds of materials from floors, walls and machinery. They are also ideal for collecting valuable residue. A very wide range of unique accessories is available and as the machines are very quiet in operation they can be used anywhere at any time. The special microfilters are available to ensure that even the smallest particles do not escape into the atmosphere.

Winkworth Machinery Ltd. (Stand No. 13).
Winkworth mixers of the latest types will be on view and at work to demonstrate blade actions.

The company's exhibits will include:

1 gallon stainless steel mixer with twin Sigma type blades revolving in opposite direction and at different speeds to each other.

Tellus Super vacuum cleaner.



Winkworth one quart laboratory mixer.

2 gallon stainless steel vacuum mixer with contra-rotating double paddle type blades.

1 quart and 1 pint easy-to-clean laboratory mixers.

Twin 3 lb. change jar revolving tumbler.

Miniature horizontal 'U' trough ribbon powder blender.

All the exhibited laboratory models are available in pilot scale and production capacities and representatives will be present to discuss laboratory small-scale and full-scale requirements.

A. D. Wood (Stand No. 10).
This company will be showing, for the first time, the complete range of equipment which they supply, and also some of their own range of high vacuum glass stopcocks.

The hollow key stopcocks are guaranteed down to 10^{-6} mm. Hg, while the solid key stopcocks will hold a vacuum of 10^{-2} to 10^{-3} mm. Hg. Apart from the stopcock itself, the most important factor when concerned with high vacuum is the correct lubrication of the key. The company's catalogue devotes a full page to recommended methods of greasing stopcocks. Samples of fully tested spring loaded stopcocks will also be on show.

For the first time they will also be showing coiled glass capillary spirals. The tubing, with a bore of eight-thousandths of an inch, is for use as columns in gas liquid chromatography. Used with the new ionization detectors, they are proving remarkably efficient, especially at high temperatures.

Also on show will be samples of the following apparatus which is supplied off the shelf: Quickfit & Quartz apparatus; Edwards High Vacuum pumps and accessories; graduated glassware; laboratory appliances and scaffolding; rubber ware; plastic ware, and also two latest additions to their range—E-Mil laboratory glassware and the Pyrex range.

Worcester Royal Porcelain Co. Ltd. (Stand No. 11).
This stand will be shared by the Worcester Royal Porcelain Co., Ltd., and John Moncrieff Ltd. The exhibit of the first-named company will consist of a general range of laboratory porcelain, such as basins, crucible, funnels, etc. Copies of the latest catalogue will be available at the exhibition.

The latter company will show general furnace made laboratory glassware of Monax glass such as beakers, flasks, etc., and the Perth branded glassware in the form of aspirators, desiccators, etc.

X-Lon Products Ltd. (Stand No. 8).
Principal exhibits on this stand will be plastic equipment for laboratories and chemical plant.

The greatly enlarged ranges which will be shown will give very striking evidence of the developments that have taken place in the last two years and which, as a result of design ingenuity, and particularly the development of important new plastic materials, have established plastic equipment in so many scientific and industrial fields.

Laboratory products will include such standard items as beakers, measuring cylinders, wash bottles, weighing bottles, plastic encased magnetic stirrers, Buchner funnels, pipette washers, etc. but examples of their specialized fabrications will also be shown, particularly in connection with laboratory installations and chemical plant.

Polypropylene became available for the first time in this country last summer and this has been adopted for much of the company's equipment, where its fine finish and excellent temperature resistance up to 140°C. have given it advantages over older forms of polythene. Being more transparent than polythene, it is particularly useful for measuring cylinders and beakers, since the levels of the liquids can be clearly seen through its walls.

The range of products in p.t.f.e. has been greatly increased and such items as evaporating dishes, stirrers, bottles and magnets encased in p.t.f.e. will be shown.

One particular new development of special interest is a controlled temperature bath in which the heat is supplied by a graphite coated epoxy resin electric element which is embedded in the polyester glass fibre body of the bath itself. The important, and recently patented, principle involved, has a host of potential applications to many industries other than the photographic, for which this exhibit has been designed.

* * *

Since the foregoing preview was prepared, the following details have been received from some late participants in the exhibition:

Geo. M. Hammer & Co., Ltd. (Stand No. 66).
Particular interest will be shown in the part section island bench, 13 ft. 6 in. long × 4 ft. 9 in. wide × 3 ft. 0 in. high, being supplied to Birmingham University. Novel features include polythene plumbing and trough through the centre of the bench. The top is of teak and the underbench drawer and cupboard units are constructed with show timber of sapele mahogany. Among other furniture, will be shown a neat, contemporary bucket seat stool; the turned legs are made in beech and the seat of mahogany is finished in a heat, acid and spirit resistant catalyst lacquer. Also on show will be examples and photographs of the 'U' complete range of office furniture, designed by Basil Spence, R.A., & Partners and selling within the prices laid down by the University Grants Commission.

Laboratory & Electrical Engineering Co. (Stand No. 31).
On this stand will be found some of the latest developments in laboratory incubation. The LEEC 'Precision' incubator is claimed to have the lowest ever in temperature variation. At 37°C. the differential is less than 0·5°C. *throughout the entire chamber*—at 56°C. less than 1·0°C. Among other developments is the automatic interior lighting. Then there is the spring loaded instrument panel which gives immediate access to the mains voltage setting, and for the replacement of bulbs and striplights. Of the four shelves supplied (two are perforated and two mesh), the mesh are of particular interest, their construction allowing air to circulate freely through the shelves, ensuring a considerable reduction in drying time when the incubator is used for this purpose.

The 'Gerflex' lightweight flexible drive machine, another product to be shown is a cleaning appliance for laboratory glassware.

The 'Gerflex' is portable and operates at a range of different speeds. It is absolutely safe, as the release of the finger operated lever instantly disengages the rotary friction clutch.

The conventional brushing and needle sharpening attachment and mercury-vapour U.V. lamp will also be displayed. This lamp is supplied with ammon-copper sulphate filter for fluorescence microscopy and Chance OXl filter for excitation of fluorescent substances.

Ralph Cuthbert Ltd. (Stand No. 60).
On this stand will be seen DAG vacuum ovens, DAG submersible, drum barrel and vessel emptying pumps, the Gainsborough range of ovens, incubators, water baths and flask heaters, Uniframe laboratory scaffolding, electric furnaces, the Houseman & Thompson water test kit; laboratory furniture and a comprehensive range of glassware.

Cooke, Troughton & Simms Ltd. (Stand No. 64).
The basic McArthur microscope which has now been taken over by Cooke, Troughton & Simms Ltd., together with a whole series of accessories, will be displayed.

On the stand some 12 or 15 of these microscopes will be set up to show their scope in general laboratory work. This will range from field work (these microscopes were used, for example, in the Antarctic) to high-class laboratory work.

UNITED TRADE PRESS LTD. STAND No. 61

On display will be some of the Company's publications:

Laboratory Practice, a monthly journal covering the practical aspects of all sciences, including new equipment, new techniques, process control, organization, teaching and research. Annual subscription £2. 5s., postage free (U.K. only), single copies 4s.

Instrument Practice, a monthly journal covering the whole field of instrument technology and instrumentation. Annual subscription £2. 10s., postage free (U.K. only), single copies 4s. 6d.

Radio & Electronic Components, a monthly journal devoted to the design and application of radio and electronic components. Annual subscription £2. 2s., postage free (U.K. only), single copies 3s. 6d.

Automation & Automatic Equipment News, a monthly journal devoted to the subject of automation, covering latest news and developments in this field. Annual subscription £2. 2s., postage free (U.K. only), single copies 3s. 6d.

The Instrument Manual, covers in detail the principles and application of instrument practice and technology. £5. 5s.

British Instruments Directory and Buyers' Guide, an authoritative guide to all the principal manufacturers and suppliers of scientific and industrial instruments, automation systems and their component parts. £2. 5s. postage free.

A Course in Industrial Instrument Technology, by J. T. Miller. 20s. postage free.

The Industrial Application of pH Measurement & Control, by D. Colver Nutting. 5s. postage free.

MEMBERS OF THE STAFF WILL BE PRESENT TO ADVISE AND HELP VISITORS THROUGHOUT THE EXHIBITON

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SCIENTIFIC LECTURES—

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PROGRAMME OF LECTURES

June 20

Lecture Number 1: **'The Labelled Pool Technique in Biology'.** (10 a.m.)
Lecturer: **Mr. F. P. W. Winteringham,** Head of the Biochemistry Department at the Pest Infestation Laboratory (Agricultural Research Council).
Chairman: **Professor A. Wormall,** Professor of Biochemistry at St. Bartholomew's Medical School, London.

Lecture Number 2: **'Indicators'.** (11.30 a.m.)
Lecturer: **Professor R. Belcher,** Professor of Analytical Chemistry, Birmingham University.
Chairman: **Professor F. C. Tompkins,** Professor of Physical Chemistry at Imperial College, London.

Lecture Number 3: **'Ion Exchange Techniques'.** (3 p.m.)
Lecturer: **Dr. J. E. Salmon,** Head of the Chemistry Department, Battersea College of Technology.
Chairman: **Professor D. P. Craig,** Professor of Chemistry, University College, London.

June 21

Lecture Number 4: **'Polarography in the Food and Beverage Industries'.** (10 a.m.)
Lecturer: **Mr. J. Hetman,** Chief Chemist, Southern Instrument Company Ltd., Camberley, Surrey.
Chairman: **Dr. J. D. Mounfield,** Principal, National College of Food Technology, Weybridge, Surrey.

Lecture Number 5: **'Glass as a Laboratory Material'.** (11.30 a.m.)
Lecturer: **Professor R. W. Douglas,** Professor of Glass Technology, Sheffield University.
Chairman: **Professor S. Tolansky,** Professor of Physics, Royal Holloway College, Englefield Green, Surrey.

Lecture Number 6: **'Rheology'.** (3 p.m.)
Lecturer: **Dr. G. W. Scott-Blair,** Head of the Physics Department, National Institute for Research in Dairying, Shinfield, Nr. Reading, Berks.
Chairman: **Dr. G. I. Finch,** formerly Director, National Chemical Laboratory, India.

June 22

Lecture Number 7: **'Micrurgy, Devices and Techniques in Biology and other Sciences'.** (10 a.m.)
Lecturer: **Mr. A. E. Saunders-Singer,** Managing Director, Singer Instrument Company.
Chairman: **Dr. E. Hindle,** formerly Director, Zoological Society.

Lecture Number 8: **'Small Scale Manipulation'.** (11.30 a.m.)
Lecturer: **Mr. M. A. Fill,** Head of the Chemistry Department, Norwood Technical College.
Chairman: **Dr. J. G. Davis,** Chairman of the Association of Consulting Scientists.

Lecture Number 9: **'Gas Chromatography'.** (3 p.m.)
Lecturer: **Dr. A. T. James,** a Departmental Head, National Institute for Medical Research, Mill Hill, London, N.W.
Chairman: **Professor H. D. Kay,** Director, Twyford Laboratories, Park Royal, London.

June 23

Lecture Number 10: **'Laboratory Computers'.** (10 a.m.)
Lecturer: **Dr. A. D. Booth,** Head of Computer Department, Birkbeck College, London.
Chairman: **Professor J. D. Bernal,** Professor of Physics, Birkbeck College, London.

Lecture Number 11: **'Clinical Biochemistry'.** (11.30 a.m.)
Lecturer: **Professor E. J. King,** Professor of Biochemistry, Post Graduate Medical School, Hammersmith, W.6.
Chairman: **Sir Charles Dodds,** Professor of Biochemistry and Director of the Courtauld Institute, Middlesex Hospital, London.

Lecture Number 12: **'Safety Techniques in the Microbiological Laboratory'.** (3 p.m.)
Lecturer: **Surg. Cdr. H. M. Darlow, R.N.,** a Departmental Head, Microbiological Research Station, Porton, Wilts.
Chairman: **Professor A. A. Miles,** Director of the Lister Institute, London.

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EMULSIONS: THEIR PROPERTIES AND USES

by F. O. Howitt, Ph.D., D.Sc., F.R.I.C., F.T.I.

Chief Chemist, Wool Industries Research Association

Part I—EMULSIONS IN THE TEXTILE INDUSTRY

This paper is the text of the first of a series of lectures given at the Derby and District College of Technology in a course on 'Emulsions: Their Properties and Uses'

Some Theoretical Considerations

Emulsions may be conveniently defined as dispersions of one liquid in another, immiscible liquid. The two liquids are most frequently water and oil and any general discussion on emulsions is based on these two liquids. Such emulsions exist in two types, namely, water-in-oil and oil-in-water, in which the first-named phase is the disperse phase and the second-named phase is the continuous phase. The type of emulsion formed under given conditions depends partly on the proportions of the two liquids: if the system contains a small proportion of the oil (or water) phase, the formation of an oil-in-water (or a water-in-oil) emulsion is favoured. There is another factor, however, which is of greater importance in the resulting type of emulsion. This is the presence of a surface-active substance that modifies the surface of the interface between dispersed and continuous phases and hence determines the equilibrium or state of minimum free energy of the system.

The surface-active additive, or emulsifier, is considered to form a layer between the disperse and continuous phases. This layer has a definite surface tension with regard to the oil on the one side and a definite, but different, surface tension with regard to the aqueous phase on the other side. If the first (layer-oil) tension is greater than the second (layer-water), the oil surface will tend to form a convex surface and an oil-in-water emulsion will result.

The main characteristic of an emulsion is the greatly increased surface presented by the interface. Thus, with olive oil, for example, if 10 ml. are dispersed to give droplets of $0{\cdot}1\mu$ diameter, the number of droplets will be $2{\cdot}4 \times 10^{15}$ with a total surface area of about 300 sq. cm. This area is created against interfacial forces that tend to reduce the interface to a minimum; hence the work of emulsification(W) is

$$W = \delta_i \Delta_s$$

where δ_i is the interfacial tension and Δ_s is the increase in surface area. For our example of 10 ml. of olive oil, W equals 1·65 g.-cal. The interfacial tension between olive oil and water is approximately 23 dynes/cm. The addition in appropriate concentration of a surface-active substance, such as soap, will lower this tension to about 2 dynes/cm. and hence the potential energy of the system will be reduced from 1·65 to 0·13 g.-cal. This means that, in the presence of the surface-active substance, less energy is required in order to form the emulsion and, correspondingly, the stability of the dispersion is increased. It follows that, when we are concerned with the practical aspects of emulsions, the most important consideration is the part played by surface-active substances acting as stabilizers of emulsion systems. This practical importance is, of course,

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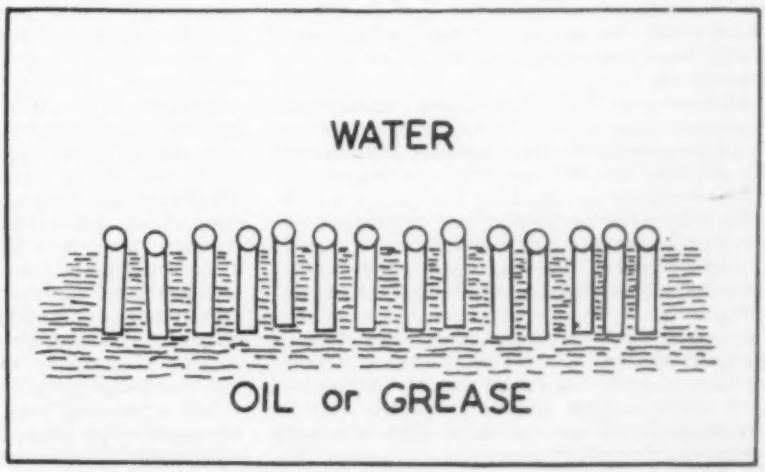
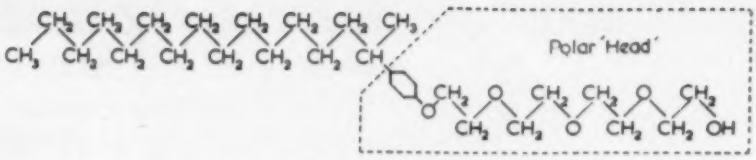
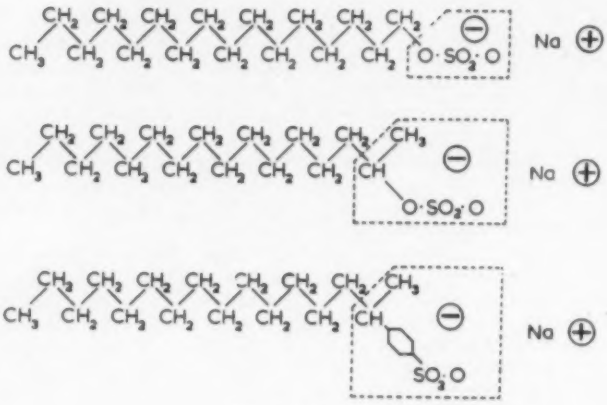


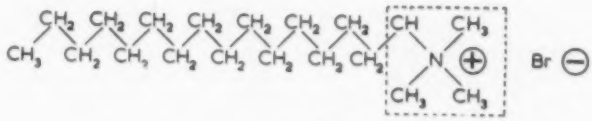
Fig. 1. Representation of detergent molecules absorbed at a water-oil interface.



Type. I. Non-Ionic



Type. 2. Anionic



Type. 3. Cationic

Fig. 2. Representative molecular structures of the three main types of synthetic detergent.

largely dependent on economic factors; a suitable surface-active substance, functioning as a detergent, can, when used at very low concentrations, remove grease with an efficiency equal to that achieved when a far greater volume, at a correspondingly higher cost, of organic solvent is used.

It will be appropriate at this stage to survey briefly the structural and interfacial characteristics of surface-active substances or rather of detergents, for, although all detergents are surface active, not all surface-active agents are detergents.

Nearly all detergents have a common structural characteristic in that they have a long part of the molecule (e.g. a hydrocarbon chain) that is soluble in oil and fats and a short part (e.g. a sodium carboxylate group) that is soluble in water. For convenience we can refer to these parts as the 'tail' and 'head', respectively.

At a water-oil interface, the detergent molecules are absorbed and form an interfacial layer by the oil-soluble 'tails' dissolving in the oil with the water-soluble 'heads' protruding into the water layer, as shown in Fig. 1.

With soaps, for example, it might be expected that they would be insoluble in oil alone or in water alone. This is practically true, for soaps have a surprisingly low solubility in water but rather are dispersed by micelle formation.

The soaps, such as sodium stearate or oleate, have been partly superseded as detergents by a wide range of 'synthetic detergents' and these consist of three types, non-ionic, anionic, and cationic. They are exemplified in Fig. 2.

Soaps fall into the anionic type. The synthetic detergents have an advantage over soap in not forming insoluble products with the calcium or magnesium in hard water; they are therefore especially useful in scouring slipe wool, i.e. wool that has been removed by means of calcium sulphide paints.

The Use of Emulsions in the Textile Industry

Oil emulsions, almost invariably oil-in-water systems, enter into textile processes in two main classes of operation, first, the deposition of oil on to fibres, yarns, or fabrics and, secondly, the removal of oil or grease from such materials. In the latter connection, we are of course concerned with the wide field of detergency and some consideration of this will be included in our treatment of textile scouring.

Textile fibres are treated with oil for two main purposes, (*a*) surface lubrication of the fibre or yarn, and (*b*) softening of a fibre, yarn, or fabric. Correct lubrication of textile material is essential owing to the considerable frictional forces that come into play during winding, carding, combing, etc., while the softening effect is of special importance in processes, principally those of knitting, where a yarn of filament must readily take up a special configuration.

With regard to friction, proper lubrication not only minimizes tension effects and hence reduces fibre and yarn breakage but also reduces wear and abrasion of

machine parts. A third purpose of the oil, of more recent introduction, is that of conferring antistatic properties on the treated material. Practically all the oil that is applied to fibres or yarns must, at some subsequent stage of processing or finishing, be removed and hence a high degree of scourability is essential; moreover, the oil should not impart colour to the yarn directly or after storage.

The oils are blended from (*a*) saponifiable, non-drying oils such as olive, sperm, etc., (*b*) mineral oils, (*c*) sulphonated and sulphated oils, and (*d*) synthetic emulsifiers and other chemical additives (e.g. derivatives of ethylene-oxide condensates, triethanolamine salts of fatty acids). A wide range of synthetic organic compounds is now used in order to confer emulsifiability and antistatic properties.

Cotton.—Cotton warps are sized with starch or modified starch that has been cooked and homogenized with about 8-10 per cent of tallow. Such a size is of course not a simple emulsion but a complex dispersion in which any oil or fat droplets are coated with the hydrophilic starch material. Vegetable gums in presence of other lubricants, such as castor oil, are sometimes used.

Jute.—Preparatory to drafting and spinning, the crude jute fibres are softened and lubricated by treatment with a 30 per cent oil emulsion, the oil being generally 80 per cent of mineral and 20 per cent of whale oil. The fibre is then passed over a breaker card which, besides attenuating and orienting the fibres, breaks up the mesh structure and reduces the fibre length to dimensions suitable for subsequent processing.

Rayons.—Oils used on rayon yarns (hank, cake, or on bobbin) are generally applied neat; such oils must be readily emulsifiable so as to ensure their rapid removal on subsequent scouring. Oil emulsions, however, are sometimes applied to give a finish to rayon; application is by soaking the cakes in the emulsion.

For rayon staple warps, sulphonated oils (e.g. olive) are used in conjunction with water-soluble sizes such as gelatin, tragacanth or soluble starch.

Hosiery Yarns (*Nylon, Terylene, Rayon, etc.*).—Nylon filaments are treated with a lubricant, often a normal oil, and, frequently, with a size, e.g. of polyvinyl alcohol, to protect the fine filaments during winding, throwing, etc. During knitting it is essential to lubricate and soften the yarns and this is achieved by passing the yarn through a dilute emulsion so that any size on the yarn is softened but not stripped. This treatment reduces abrasive action on carrier tubes and needles and, by giving an even coefficient of friction, contributes to evenness in loop formation. There is a tendency today to use pure oil preparations in place of emulsions for nylon knitting, but the softening effect of moisture is essential with the hydrophilic fibres such as viscose and silk.

The modern type of self-scouring oils used for lubricating the needles of knitting machines is exemplified[1] by a mixture of a light sinker oil, i.e. a mineral oil (100 parts), Lissapol NX (10-15 parts) and Lubrol MOA (10-15 parts): the latter two compounds are ethylene-oxide derivatives of an alkylphenol and a fatty alcohol, respectively. The mixed oil is stabilized with up to 2 parts of water, probably by formation of a water-in-oil dispersion. This mixture can be added (2½ parts) with sodium benzoate (1 part) to water (100 parts) to give an oil-in-water emulsion that is useful in the wetting-out of nylon yarns prior to knitting on fully fashioned machines.

Silk.—Raw silk is treated with some form of oil-in-water emulsion before 'throwing', in order to soften the gum layer and to lubricate the threads. The earliest types of emulsion were of oil (generally olive or neats-foot) dispersed in aqueous soap solutions, with or without a small concentration of a mild alkali such as borax. The modern type of soaking oil consists of a mixture of soluble (e.g. sulphonated) oil, wetting agent, plasticizer, and mildew preventive, which is dispersed in water to give an emulsion that is stabilized by a mild alkali (e.g. Crex). Normal glyceride oils are often incorporated and mineral oil (up to 30 per cent) is frequently present. Even when mineral oil is a constituent, a good soaking oil is 'self-emulsifiable' and forms spontaneously a stable milky fluid on pouring into water containing the appropriate alkali. The silk is soaked (silk: liquor ratio of about 1: 5) in the warm emulsion overnight and exhaustion of the oil is practically complete, i.e. the liquor is water-clear or very faintly milky.

A survey[2] of the technology of silk reveals a method of processing that is related to the use of emulsions in that a water-air system, i.e. a foam is used in place of a water-oil system. The first application of the method, in 1904, was the degumming of silk by suspending the raw silk in the foam or lather arising from a soap bath heated by an open steam coil. The mechanism of the process is probably dissolution of the sericin by the hot liquid phase and dispersal of the surface-active protein on the air-liquid interface. It is of interest here to note that Stevenson has recently postulated a similar phenomenon for the dispersal of dirt by a soap lather. The foam process was at a later date also applied to the weighting of silk by direct treatment with metal chlorides followed by application of phosphate and silicate solutions in the form of froth or foam baths. The foam method was also the basis of a patent claim as a method of dyeing. The general method of foam application, however, was not adopted despite its early promise.

Before dealing with emulsions in relation to wool technology, which is the main concern of this paper, it is of interest to note the application of emulsions to textile printing and finishing.

In textile printing, the dye is applied in the form of a paste that has a definite viscosity, generally between 500 and 5,000 centipoises, depending on the method of application and the fabric being printed. This viscosity is commonly achieved by the use of gums such as British gum (a type of dextrin), tragacanth, etc., but recent work[3] has shown that these thickening agents can be replaced by suitable emulsion systems, preferably

of the oil-in-water type. A surface-active agent, such as Lissolamine A, Lissapol N, or sodium lauryl sulphate can be used, while the addition of an auxiliary film-forming agent having good flow properties, e.g. sodium alginate, will help considerably in stabilizing the emulsion and conferring suitable flow properties to the emulsion. Emulsion thickening can be used for both section and roller printing, but are not suitable for block printing; they can be applied to nylon, acetate, polyester, and acrylic fibres.

Emulsions are widely used in textile finishing processes. Thus fabrics can be water-proofed by application of waxes dispersed as an oil-in-water emulsion. Flame-proofing preparations are often applied either as an oil-in-water or a water-in-oil emulsion; an example is a dispersion of chlorinated hydrocarbon and antimony oxide in presence of naphtha, oleic acid, ammonia, and methyl cellulose in water. The application of thermo-plastic resins depends on the production of these materials in the form of aqueous emulsions by the technique of emulsion polymerization.

The methods of preparing emulsions are well known. In the textile industry high-speed stirring and simple types of emulsifying mills are used. Attention is now also directed to the supersonic methods of dispersion. True supersonic vibrations such as produced by the magneto-stricter apparatus have been examined for the dispersion of oil material from rayon waste and of soil from dirty clothes as a laundering process but the method is not economical and also difficult to carry out except in a small scale. Larger-scale apparatus, working at lower rates of vibration, is finding increased use and an excellent example is the Rapisonic[4], in which emulsification or dispersion is effected by the vibrations of a blade which vibrates at its natural frequency in the liquid stream that impinges on it at high pressure: cavitation occurs in the liquid swept out by the vibrating blade.

Wool.—Consideration will now be given to the main section of this paper, viz. the removal of grease or oil from wool fibres and, in this matter, our principal concern is the scouring of raw wool. Wool as shorn from the sheep contains a variable amount of so-called grease and the content for the finer or Merino wools is generally about 15-18 per cent by weight of the moist raw wool. Wool grease[5] is a very complex mixture of the esters formed from normal, *iso*-, ante*iso*-, and hydroxy acids and normal *iso*-, ante*iso*- and dihydroxy alcohols in presence of free and esterified sterols, mainly cholesterol: it follows that a more proper name is wool wax. Another raw wool constituent is suint, which is present in Merino wool to the extent of about 8 to 10 per cent and is the dried residue of the excretion of the sheep's sudoriferous glands. Suint is also a complex mixture of a wide range of fatty acids and keto-, hydroxy-, dicarboxylic and other acids, present mainly as the potassium salts, together with nitrogenous substances, including urea and polypeptides, and inorganic salts. As will be discussed later, suint enters into the processes of scouring and dispersion of the wool wax.

The wax on raw wool, together with the suint and most of the extraneous contaminants, are removed by scouring with a soap-soda solution or with a synthetic detergent solution in presence of a neutral or alkaline salt.

A recently re-introduced method is that of solvent scouring but this method is outside our present considerations.

Scouring is carried out at a temperature of about 50°C. so that the wool wax, which has a melting point of about 40-45°C., is in a reasonably fluid condition. The detergent then reacts with the wool wax and it is the nature of this reaction that is the crucial point in wool scouring and, indeed, in practically all other washing processes. The main aspect of this reaction is the formation of complexes between detergent and soil.

Detergency has been treated theoretically from many angles but it appears that there are at present two main theories regarding the mechanism of detergent action, although it must be recognized that the many experimental approaches to the problem do not permit an unequivocal selection of one theory and the rejection of the other. To many of us, it would appear that the truth rests with some combination of the two theories.

The first theory is that described by Lawrence[6], who has dealt with the nature of the complexes formed between soil and detergent. Thus soap/water/amphiphile systems are treated as a ternary liquid crystalline phase existing over a wide range of concentrations with dirt or soil as a fatty amphiphile. This leads to a rational

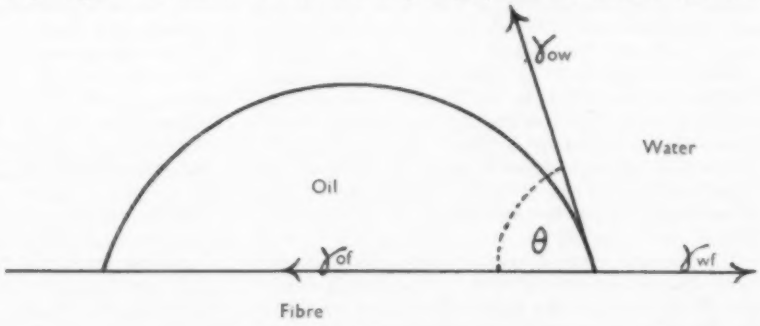


Fig. 3. Interfacial forces operating on an oil drop on the surface of a fibre immersed in an aqueous medium.

treatment of detergency in terms of cryoscopic forces.

The other theory, according to the work of Adams, Schulman and others, depends on sequential stages of wetting-out of the fibre, displacement of the soil and emulsification of the soil. The second, and probably the most important, stage is based on an elementary consideration of contact angles.

Consider an oil drop on a fibre that is immersed in water. Then the simple interfacial diagram will be as in Fig. 3, where θ is the contact angle measured in the oil phase: it follows that $\cos\theta=(\gamma_{wf}-\gamma_{of})/\gamma_{ow}$.

For ease of removal, the oil drop must approach as near as possible to a spherical form, thus making the area of contact with the fibre as small as possible, i.e. θ must approach 180° or $\cos\theta\rightarrow -1$.

The quantity $\gamma_{wf}-\gamma_{of}$ has been defined as the difference in surface pressure between the film of detergent molecules absorbed on the water/fibre interface and any film of molecules absorbed or present at the oil/fibre interface. Hence for a spherical drop to form, γ_{wf} and γ_{ow} must be small, i.e. low values of the oil/water interfacial tension and of surface pressure in the fibre/water interface are required. This is essentially the same idea as assuming that, for grease removal, fibre surface must be modified by the detergent to produce a hydrophilic, rather than the more normal oleophilic, surface. Expressed in a more simple way, the efficiency of a detergent process will depend on

(*a*) The affinity or molecular attraction that exists between the fibre and the soil.

(*b*) The reduction in this affinity that arises by modification of fibre and oil surfaces due to interfacial absorption of the detergent used.

With (*a*), the determining factor is the polar character of the soil and fibre. This can be exemplified by some experiments of Speakman and Chamberlain[7] on the difference in extraction rates of a mixture of 97 per cent mineral oil and 3 per cent oleic acid applied, at a 5 per cent level, to cotton and wool fabrics. The fabrics were scoured twice in soap/soda solution under identical chemical and mechanical conditions and then Soxhlet-extracted with ether.

Fabric	*Residual Oil (% on Wt. of Fabric)*
Wool	2·42
Cotton	0·58

The same workers carried out a similar test on a white worsted fabric to strips of which had been applied 10 per cent of each of a number of distillation fractions of a water-white mineral oil. The oiled strips were scoured as before and the residual hydrocarbon oil was determined by Soxhlet extraction. (Table I.)

TABLE I

Boiling Range of Fractions (°C.) (at 10 mm. Hg. pressure)	*Residual Hydrocarbons (% on Wt. of Wool)*
165-175	1·80
175-185	2·90
185-200	3·59
200-220	4·54
220-240	4·82
240-260	5·37
260-280	5·90
280-300	6·10

It will be seen that the difficulty of scouring increases with increasing chain-length. The oil-water interfacial tension is largely independent of the molecular weight of the paraffin and hence the main factor is the increased adhesion associated with increased length of the paraffin molecules.

This adhesion between soil and substrate is an expression of the polar characters of these two participants in soiling, as was shown by Hardy[8] from his examination of the adhesion shown by thin films of lubricant between metal surfaces. In this connection, it is of interest to note that Speakman[7] demonstrated that the addition of about 6 per cent of oleyl alcohol to mineral oil, which resulted in a lowering of the initial oil-water interfacial tension of 47·9 to 18·9 dynes/cm., was followed by an increased ease of scouring of the mineral oil from wool; on the other hand, although oleic acid is even more effective than oleyl alcohol in reducing the oil-water interfacial tension, mixtures of mineral oil and oleic acid are not easily removed from wool by emulsification. Further, it should be noted that Stevenson[9] has recently shown that the scouring of mineral oil from wool fibres by means of soap solutions is considerably facilitated by adjusting the pH of the solution to a value around 9; this means, of course, that the soap is replaced by a mixture of soap and free fatty acid, the latter being additional to the small amount normally produced by acid hydrolysis. A related observation is that of Hartley[10], who noted that optimum scouring of an undyed worsted yarn containing 3 per cent of a castor-sperm type combing oil by sodium carbonate-bicarbonate solutions or by soap and synthetic detergent solutions was optimum at pH about 8·6. From these and other experiments, it appears that detergency depends on adhesion between soil and substrate and the modification in this adhesion due to surface-active substances, i.e. detergents. In order to throw some light on the chemical and physico-chemical processes involved, the problem was studied, with particular reference to raw wool scouring, by Harker[11] who used a photomicrographic technique.

The first system examined was that of polythene fibre and Nujol (medicinal paraffin). These two substances have a similar long-chain hydrocarbon structure and it is to be expected that, following the old adage of 'like dissolves like', the oil would readily 'wet' the

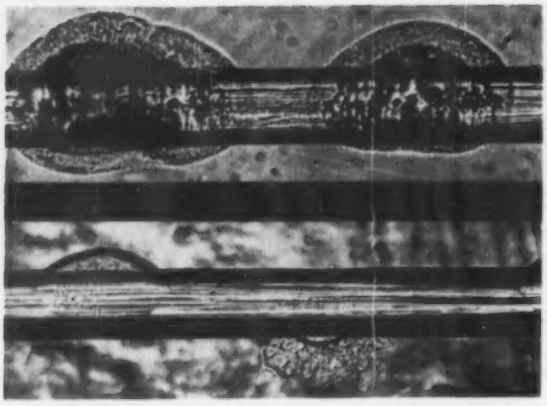


Fig. 4. Photomicrographs of (top) polythene fibres soiled with oleic acid and immersed in sodium carbonate solution and (bottom) immersed in Lissapol N solution.

polythene and adhere very strongly. This proved to be true and it was found extremely difficult to remove the oil from the polythene by purely physical (as distinct from mechanical) means. This represents the extreme case of a non-polar fibre soiled with a non-polar oil. The only types of soil easily removed were those that were capable of reacting chemically (e.g. oleic acid reacted with sodium carbonate) to form physico-chemical complexes with the detergent. This is illustrated in Fig. 4, in which the top section is a polythene fibre soiled with oleic acid and immersed in sodium carbonate solution: the formation of a soap layer of solid appearance should be noted. The bottom section is a polythene fibre soiled with oleic acid and immersed in Lissapol N solution. The more diffuse pattern of the detergent-oleic acid complex is apparent.

Fibres of polytetrafluoroethylene, as would be expected from the structure, behave in the same way as polythene fibres.

Terylene, although slightly more polar, behaves very similarly to polythene and even a very polar soil such as oleic acid does not roll up into spherical drops in detergent solutions. Fig. 5 shows a Terylene fibre and a wool fibre, both soiled with oleic acid, in the same detergent (0·1 per cent sodium myristate) solution. As can be seen, the soil on the wool fibre forms spherical drops very rapidly and is then easily removed from the fibre surface. On the other hand, the soil on the Terylene fibre shows no sign of behaving in this way. This difference between Terylene and wool fibres is illustrated by the work of Hartley[10] on the scouring of Terylene-wool blends (usually 55/45), which contain 2·5-3·0 per cent of oil (mainly combing oil). It was found that a much stronger force of adhesion existed between the oil and Terylene fibre than between the oil and wool. Under the microscope, the behaviour of combing oil on Terylene resembled that of a pure mineral oil on wool. It thus appeared that a scouring assistant effective for the removal of mineral oil from wool would be equally effective for fatty oil on Terylene and this was confirmed by successfully scouring of the Terylene-wool blend by the addition of a mixture of two non-ionic surface-active reagents to the blend during spinning.

With nylon, the apparent contact angle increases

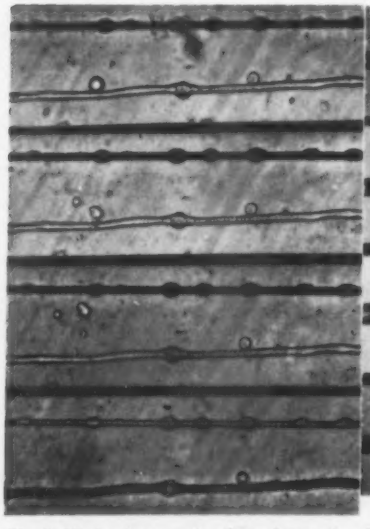


Fig. 5. Photomicrographs of Terylene and wool fibres, both soiled with oleic acid, immersed in 0·1 per cent sodium myristate solution.

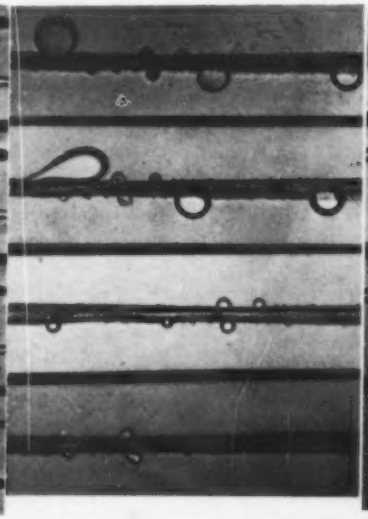


Fig. 6. Photomicrograph showing the removal of Nujol from jute fibres immersed in a 0·05 per cent solution of sodium oleate.

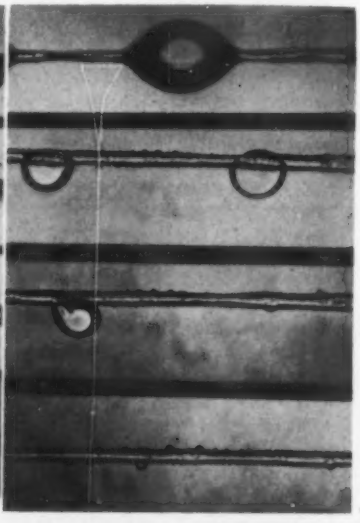


Fig. 7. Photomicrograph showing the scouring of Nujol from wool fibres by Lissapol N solution.

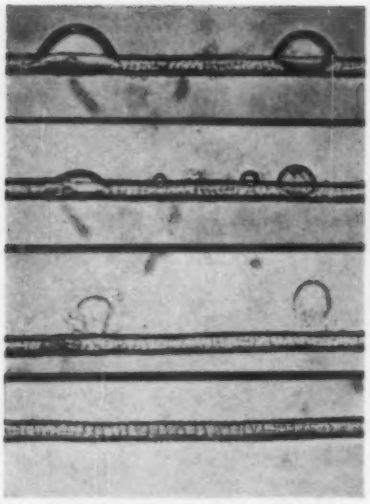


Fig. 8. Photomicrograph showing the scouring of Nujol containing 25 per cent of oleic acid from wool fibres by Lissapol N solution (compare Fig. 7).

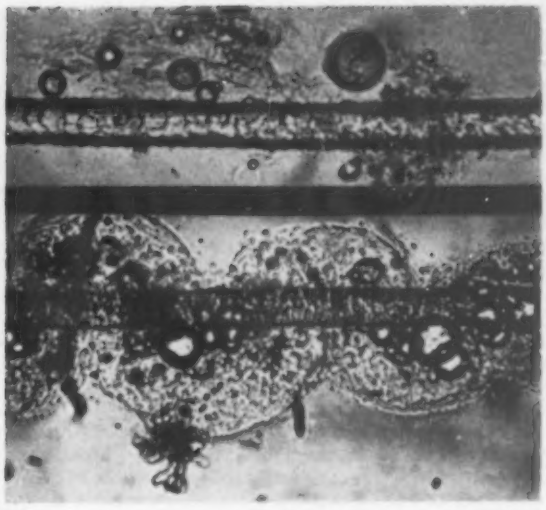


Fig. 10. Complex formation in a wool-lanolin-sodium myristate system at 60 °C.

rather more than with Terylene and the fibre is less difficult to clean. Some difference can even be observed between nylon 6·10 and nylon 6·6, a difference that is probably related to the higher content of the latter in ·NH·CO· groups.

The removal of Nujol from jute indicates that the polar fibre can be cleaned even when soiled by a very apolar soil. This is shown in Fig. 6 in which is illustrated the removal of Nujol from jute fibre immersed in a 0·05 per cent solution of sodium oleate. With such soils, however, the choice of detergent becomes of greater importance. As with wool, sodium oleate appears to be more efficient than are saturated hydrocarbon-chain derivatives and much more efficient than non-ionic species. The possibility of increasing the efficiency of sodium oleate by presence of free oleic acid, e.g. scouring at pH 8·5-9·0, has already been discussed.

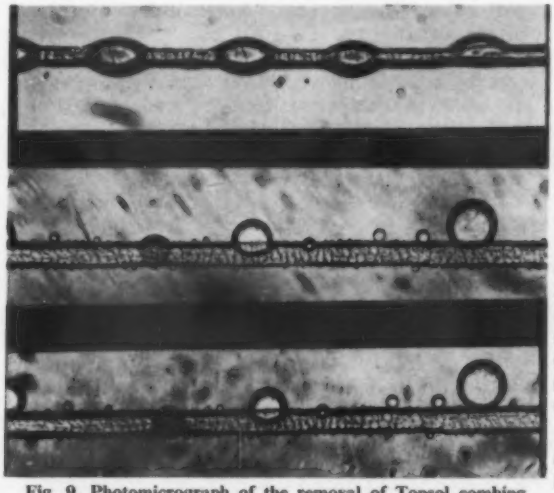


Fig. 9. Photomicrograph of the removal of Topsol combing oil from wool fibres by means of 0·1 per cent sodium myristate solution.

With wool, the addition of a polar constituent to Nujol certainly has a profound effect on the ease of soil removal. In Fig. 7 is shown the scouring of Nujol from wool fibres by Lissapol N solution: the oil is not readily dispersed. If, on the other hand, the Nujol soil contains 25 per cent of oleic acid, scouring by Lissapol N is considerably enhanced, as shown in Fig. 8.

The difference between the non-ionic detergent and the Nujol and 25 per cent oleic acid exemplifies the need for the third component or the 'amphiphile' of Lawrence. In the first case, no third component is present and, unlike with sodium oleate, no free fatty acid is formed by hydrolysis and hence must be supplied in order to obtain the close-packed layer at the interface and also some complex formation.

Thus, with polar fibres such as jute and wool, even a non-ionic detergent will produce effective 'rolling-up' and, with the addition of oleic acid, typical complex formation occurs. With polythene fibres, however, such soils can be removed only by complex formation and spherical drop formation is not observed; this is a good illustration of the importance of the chemical composition of the fibre.

The more polar soils, such as Topsol combing oil and artificially applied lanolin, are very easily removed from wool, as shown in Fig. 9, which illustrates the removal of Topsol from wool fibres by means of 0·1 per cent sodium myristate solution.

The rate at which removal of soil takes place is often dependent on temperature but only in so far as an elevated temperature reduces the viscosity of the soil, probably increases the rate of absorption of the detergent, and allows penetration and swelling to be more effective. This is very important with lanolin in the laboratory experiments and is almost certainly of importance in the scouring of raw wool. Where the rate of removal of soil is slow, complex formation is more likely to occur, due no doubt, to the fact that sufficient time is available for absorbed detergent molecules to diffuse into the soil.

An interesting example of complex formation occurs when a non-ionic detergent is added to a wool-lanolin-sodium myristate system (Fig. 10). The top section of the photomicrograph shows the normal detergent process taking place at 60°C., while the bottom section shows a wool fibre immediately after the addition of a small amount of non-ionic detergent; the appearance of the swollen soil has changed to that of a characteristic complex system. These systems tend to become very gelatinous in keeping with the increased viscosity to be expected from such an interaction and apparently are related to the gelatinous liquid-crystal layer discussed by Lawrence. The same phenomenon is illustrated in Fig. 11, in which the bottom section shows the wool-lanolin-soap system at 60°C. before, and the middle section the system after, addition of a small amount of Lissapol N.

The top section of Fig. 11 shows the detergent action of Lissapol N on wool soiled with oleic acid. The formation of myelenic forms is well illustrated.

The overall picture of increase in scourability with increase in polar character of both fibre and soil is expressed diagramatically below.

Fibre Type		*Soil Type*
P.T.F.E.		Nujol (mineral oil)
Polythene		Olive Oil
Terylene		Topsol (blended fatty oils)
Nylon 6·10		Oleic Acid
Nylon 6·6		
Jute		
Wool		

POLAR CHARACTER — INCREASE IN

Experiments with clean glass fibres show that glass behaves in a manner similar to that of Terylene. However, on coating a bundle of glass fibres with gelatin, the removal of soil was comparable with that from wool fibres. All this evidence is consistent with the difference in polar character (i.e., number and type of polar groups in the molecule) between fibres.

In consideration of the industrial scouring of raw wool, the main point of interest is the actual dispersion of the grease in the scouring bowls, irrespective of the nature of the detergent, be it anionic or non-ionic detergent or ordinary soap. There is a chemical or physico-chemical action between the detergent and the wool grease. This reaction has been included in the microscope studies of Harker[11] and what happens is shown in Figs. 12 and 13.

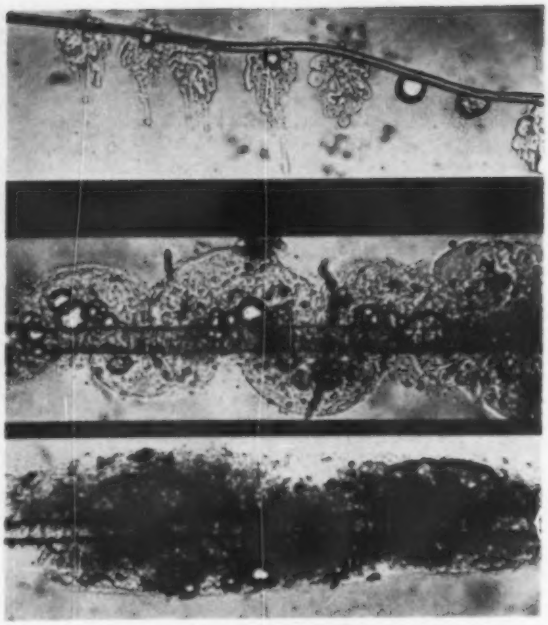


Fig. 11. The two lower photomicrographs (below the black band) show the wool-lanolin-soap system at 60°C. before (bottom) and after (middle) addition of a small amount of Lissapol N. The top section shows myelenic formation due to the detergent action of Lissapol N on wool soiled with oleic acid.

In Fig. 12, the top photomicrograph shows the appearance of the raw wool fibre immersed in water at 20°C., while the bottom photomicrograph shows the

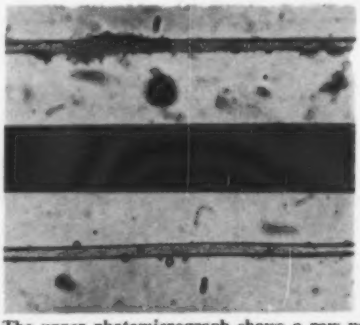


Fig. 12. The upper photomicrograph shows a raw wool fibre immersed in water at 20°C., while the lower photomicrograph shows the fibre after immersion in 0·1 per cent Lissapol N solution at 60°C.

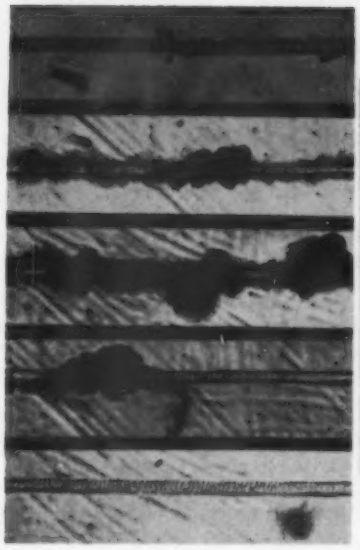


Fig. 13. (*Left.*) **Stages (from top to bottom) of the detergency of raw wool.**

Fig. 14. (*Above.*) **Photomicrograph of water droplets in an oil drop of an emulsion.**

fibre almost immediately after immersion in 0·1 per cent sodium carbonate—0·1 per cent Lissapol N solution at 60°C.; in the latter, the wool wax is being dispersed with great rapidity. The melting point of wool wax is about 40-45°C. and even at the temperature of the scouring bowl, generally about 50°C., the wool wax is still only semi-fluid. The detergent-grease complex at this temperature forms a swollen mass and this swelling process takes place during the passage of the wool through the bowl. In experimental studies, fairly vigorous movement of the detergent solution resulted in removal of the swollen complex as semi-fluid lumps (Fig. 13).

It is very probable that this mechanism of wax removal occurs through the rush of liquor at the nip of the scouring bowl and that the detached lumps are subsequently dispersed in the form of small spherical drops that normally occur in the scouring liquor. The swollen lumps released at the nip have actually been observed in liquor taken from beneath the squeeze rollers during scouring.

This mechanism for the removal of wool 'grease' from raw wool during scouring provides an explanation for the occurrence of a phenomenon that has been occasionally noted during the process. This is the formation of stable aqueous droplets within the oil phase of the oil-in-water emulsion that comprises the scouring liquor. This inverted emulsion is shown in Fig. 14, in which is seen a photomicrograph of an oil drop containing small drops of water dispersed in the oil.

It is probable that, as the rush of liquor sweeps the grease complex off the fibre, some aqueous solution becomes occluded in the swollen, hydrated soil. On dispersion in the wash liquor, the swollen soil forms emulsion drops containing water droplets: alternatively, the water of the hydrated swollen soil elements separates as the complex disintegrates and forms a detergent-stabilized system in the liberated oil phase. Some workers[12] consider that this formation of water droplets dispersed within the oil drops is responsible for the consumption of a large part of the detergent; this conclusion, of course, is based on the justifiable assumption that the water droplets are stabilized by a surface layer of the detergent.

This study of the scouring of raw wool has served to underline the importance of mechanical action in the process and there is little doubt that this factor is of equal importance in practically all processes of detergency, both industrial and domestic.

A final note can be added that concerns a further aspect of emulsions in relation to wool scouring, namely, the recovery of wool wax or lanolin from the scouring effluent. Wool wax and derived products are used for lubricants, paints, rust preventives, and as a base for cosmetic and pharmaceutical preparations in which, it should be noted, the wool wax alcohols provide the best water-in-oil emulsifying agents known.

Wool scouring effluents, when the soap-soda method is used, contain about 0·4-3 per cent of wax, appreciable amounts of soap, the wool suint constituents, and suspended sand and dirt. The oily matter is present as a fairly stable emulsion and it is probable that the polypeptide constituents of the suint significantly contribute to this stability. In this latter connection, the addition of a colloid protective agent, such as sodium carboxymethylcellulose, to the scouring liquid has been recommended in order to stabilize the emulsion of wool wax and thus minimize re-deposition of wax on the scoured wool.

The effluent is allowed to stand in sedimentation tanks so as to remove most of the gross suspended matter, mainly sand. The liquor is then cracked by addition of sulphuric acid to pH 3·5-4·0 while the liquor is well agitated, generally by means of compressed air. After standing for some hours, the liquid layer is run off to waste, and the sludge, mostly at the bottom of the cracking tank, is pumped into the 'magma tank' where it is heated before feeding to the filter presses. The expressed liquid flows into a phase separator from which the supernatant oil layer can be run off into barrels to give the crude wool grease. This process is applied by the City of Bradford Corporation at its Esholt works to the whole of the Bradford area sewage, some 20 million gallons per day, with an annual yield of the order of 10,000 tons of crude grease.

Where synthetic detergents are used for wool scouring, mainly on the Continent and in U.S.A., the wax is separated by direct multiple centrifugation of the hot, sedimented effluent. The yield by this process is, however, low although greater efficiency has been claimed for supplementary treatment at the appropriate stage by addition of a low concentration of salt[13] or of a coagulant such as Bentonite[14].

One process that, in various forms, has been described over the past century and has recently been reintroduced by Australian workers, is the production of a foam so that the surface-active wax is absorbed at the air-liquid interface; the foam is separated and broken down by suitable heat treatment.

Analytical Methods

Finally, the following brief notes on analytical methods that have been developed at the Wool Industries Research Association might be of interest to those concerned with emulsions.

Soap-Lanolin Dispersions.—The emulsion is percolated through a column of activated charcoal mixed with Zeokarb 225. The soap is cracked to fatty acid which together with the lanolin is absorbed. The fatty acid is eluted with hot ethanol (absolute or 90 per cent) and the lanolin is subsequently eluted with hot trichloroethylene. The fatty acid fraction can be weighed or titrated and the lanolin fraction is weighed after removal of solvent. Alternatively, both fatty acid and lanolin can be eluted with hot benzene-methanol (2:3) and the fatty acid content found by titration.

Lissapol N-Lanolin.—The emulsion is cracked and absorbed on a Bio-deminrolit column. Lissapol N is then eluted by means of 50 per cent aqueous ethanol and the lanolin subsequently eluted with trichloroethylene.

Emulsions containing Mineral Oil, Olive Oil and Lissapol N.—The emulsion is cracked and absorbed on columns of activated charcoal containing 5 per cent of Bio-deminrolit. Subsequent elution with acetone-chloroform mixture allows almost complete separation of olive oil and mineral oil.

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BOOK REVIEWS

Milk Testing, by J. G. Davis, D.Sc., Ph.D., F.R.I.C. Second edition. London: Dairy Industries Ltd. 1959. pp. 309. 30s.

It is ten years since the first edition of this invaluable reference book was published. The author has attempted in this second edition, to bring up to date the techniques of the various tests used in Britain for the routine control of milk and cream.

Although it is primarily written for those concerned with laboratory work in creamery and dairy laboratories it is to the writer's knowledge much used in teaching and advisory laboratories, because it is the only book which deals comprehensively with the physical, chemical and bacteriological tests of milk commonly used in Britain.

Its contents include 20 pages on sampling, 28 on physical tests, 46 on chemical tests, 14 on biochemical tests, 119 on bacteriological tests and 35 on organization of the dairy control laboratory.

Detailed techniques of the more important routine tests are given, while references are given to methods which may be required for special purposes. The reference section, which covers 10 pages, is quite comprehensive and up to date.

Each test is described systematically under object of test, principle of method, apparatus required, technique of test, and interpretation of results. The latter could quite usefully be extended, particularly in the case of the routine bacteriological tests. Instead of quoting references to critical studies of various bacteriological tests, the author could enhance the value of the next edition considerably by giving brief summaries of the results of such critical studies and by giving his own views, which are founded on a very wide experience of bacteriological control work.

This new edition of 'Milk Testing' will also enable dairy scientists and technologists in other dairying countries to appreciate the way in which the routine tests now commonly employed in Britain have evolved as the result of much research and practical, commercial application during the past 20 years or so. It is evident that emphasis has been given throughout to the development of accurate, simple and economical tests, the results of which can be easily interpreted and applied quickly, so as to assist in the improvement of methods of milk production, processing and manufacture.

The second edition of this book is strongly recommended as a laboratory manual for dairy students, dairy chemists and bacteriologists and creamery managers who aim to keep abreast of modern developments in dairy technology.—S. B. THOMAS.

ROYAL SOCIETY TERCENTENARY

The July issue of *Laboratory Practice* will be a special number comprising articles by members of the Journal's Scientific Advisory Committee and other Fellows of the Royal Society.

APPARATUS AND DEVICES

A SPEKKER CALIBRATION CURVE FOR VITAMIN E ROUTINE DETERMINATIONS

by J. E. McEwen, A.I.S.T.

Agricultural Chemistry Department, North of Scotland College of Agriculture

DUE to the recent report by the Analytical Methods Committee of the Society for Analytical Chemists on Vitamin E (1959) it was decided to try out the method described and to use the Spekker for measuring the concentration of vitamin E present in prepared solutions.

Standards were prepared in duplicate from a stock standard solution of pure α-tocopherol in ethanol with a concentration of 10·5 μg per ml. These were read in the Spekker and the following curve obtained (Fig. 1).

Nine solutions were made up in duplicate from the stock standard solution by taking quantities of 0·5, 1·0, 1·5, 2·0, 2·5, 3, 4, 5 and 6 ml., the first eight being diluted to 6 ml. with ethanol. To each solution was added 1 ml. 2:2′-dipyridyl, then taking the standards in batches of three, 1 ml. ferric chloride was added at 15 second intervals and each transferred to 1 cm. cells and read after one minute in the Spekker.

The Spekker drum was set at 1·30 (density scale) using as a blank, 6 ml. ethanol, 1 ml. 2:2′-dipyridyl and 1 ml. ferric chloride. Kodak No. 549 blue-green filters were used with maximum sensitivity and the readings for the nine standards were as shown in the Table.

Results obtained, using the above standard calibration curve, from plasma from vitamin E deficient pigs, were in the region of 1·7 μgm. per 10 ml. to 3·0 μg. per 10 ml. of plasma used and although very low, as expected, were still able to be read.

These results on being compared with results by other workers on the same plasmas were found to be in good agreement although different instruments were used for determining the concentration present.

Since only total tocopherols were determined in the plasmas submitted the following steps of the method were used:

(*a*) Solvent extraction of the plasma.

(*b*) Saponification.

(*c*) Column chromatography on floridin earth to remove interfering substances.

(*d*) The total tocopherols estimated by 2:2′-dipyridyl-ferric chloride according to the method of Emmerie and Engel (1938).

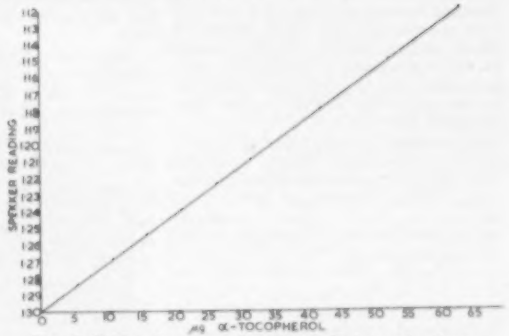


Fig. 1. Calibration curve for vitamin E determinations.

Conclusion

Although the few results so far obtained have been most encouraging it is thought that even more suitable filters might be obtained from the manufacturers which would give a wider range to work on. This in turn would help with future work intended to be carried out on further samples of plasma from vitamin E deficient animals.

ACKNOWLEDGMENTS.—*I wish to thank Dr. G. A. Garton and Mr. W. R. H. Duncan of the Rowett Research Institute for their valuable assistance and encouragement. My thanks are also due to Mr. P. L. Shanks the Veterinary Investigation Officer of this College in conjunction with whose Department this work is being carried out.*

REFERENCES

Report on Vitamin E. (1959). Analyst, **84**, 356.
Emmerie, and Engel, C. (1938). Rec. Trav. Chim. Pays. Bas. **57**, 1351.

	Stock Standard Solution ml.	*Ethanol* ml.	*α-tocopherol equivalent* μg	*Drum Reading*
1	0·5	5·5	5·25	1·285
2	1·0	5·0	10·50	1·270
3	1·5	4·5	15·75	1·255
4	2·0	4·0	21·00	1·240
5	2·5	3·5	26·25	1·225
6	3·0	3·0	31·50	1·210
7	4·0	2·0	42·00	1·180
8	5·0	1·0	52·50	1·150
9	6·0	nil	63·00	1·120

News from the British Association of Chemists

Federation Internationale des Cadres de la Chimie et des Industries Annexes

It is now possible to give some details of the meetings to which reference was made on this page in the last issue of *Laboratory Practice*. At the public meeting arranged by the B.A.C., and held at the Charing Cross Hotel on May 6, representatives of a number of British professional associations, whose members are scientists, engineers, accountants, law officers, etc., were present.

The object of the meeting was to enable them to meet officers of not only F.I.C.C.I.A., but of the Confédération Internationale des Cadres (C.I.C.) and to hear what these bodies have actually achieved on behalf of professional men in Western Europe. Dr. A. Ferrero of Switzerland, who is President of F.I.C.C.I.A., President of La Chambres Suisse des Chimistes, and Permanent Representative of the C.I.C. at the I.L.O. at Geneva, gave a summary of the history and achievements of F.I.C.C.I.A. and of the C.I.C., as well as a report on the I.L.O. Conference at Geneva in June, 1959. At that Conference the problems of the 'Cadres' of professional men occupied a prominent place on the Agenda for the first time. Dr. Ferrero said that as a result of the efforts of the C.I.C., the I.L.O. undertook to study, among others, particular matters concerning professional men as follows:

1. The terms of Service Agreements with particular reference to restrictive clauses.

2. The establishment of an international standard for securing appropriate rewards for the 'salaried inventor'.

3. The transfer of pension rights when changing employment.

4. The problem of securing re-employment in the case of professional men over the age of 40.

Dr. Ferrero mentioned that the resolutions put forward by the C.I.C. in connection with Items 1 and 2 above had actually been prepared by F.I.C.C.I.A. This latter body had appointed special committees for this purpose which had gathered and collated information as to the practice in Great Britain, France, Western Germany, Italy and Switzerland. As a result this valuable and considerable amount of work, rendered possible by the Professional Organizations in the countries concerned having joined together, enabled the resolutions put forward to be supported by a widespread factual summary.

Mr. J. Caillaud of France spoke of the Collective Agreements affecting the remuneration and conditions of professional men which had already been negotiated in France, Western Germany and Italy. These had secured considerable benefits for those concerned and it was interesting to note that the original German one was negotiated over 40 years ago.

Dr. Guthke, Western Germany, gave a summary of the position with regard to the rewards of the 'salaried inventor' and of pension rights in various countries.

There was a long and very interesting discussion on particular points raised by some of those present, which were answered very fully by the visitors. The information given by the Continental representatives was received by those present with the utmost interest. It appeared that the professional men in Western Europe were, generally speaking, in a much stronger position as a result of their having combined together than their counterparts in this country.

The point was made that the C.I.C. is itself an international association composed of national associations of professional men. The national associations are themselves composed of associations of individuals engaged on particular professions.

In addition there are some international associations, each concerned with a particular profession, composed of national associations of individuals engaged in that profession—of which F.I.C.C.I.A. is an example. These also belong to the C.I.C.

The hope was expressed that there would soon be a national association of British professional bodies which would become associated with the C.I.C. and and thus add their weight to the latter's influence as well as having the advantage of the backing of the C.I.C. in case of need.

At the meeting of the Assemblée Générale of F.I.C.C.I.A. held on Saturday, May 7, the following officers were elected:

President: Dr. F. W. Guthke (Western Germany) Verband Angestellter Akademiker der Chemischen Industrie.

Vice-President: Mr. J. Caillaud (France) Féderation Nationale des Syndicats de Cadres des Industries Chimiques.

General Secretary: Dr A. Ferrero (Switzerland) Association Suisse des Chimistes.

Treasurer: Mr. C. H. Bowyer (Great Britain) British Association of Chemists.

All correspondence and enquiries concerning this Association should be addressed to G. R. Langdale, Esq., The British Association of Chemists, Nomination Dept., 14 Harley Street, London, W.1. Tel.: Museum 7021.

OBITUARY

The decease of the following is announced with regret:

Mr. James Ramsay Hannay, of 21 Carmel Gardens, Darlington, a Founder Member of the B.A.C. (1917/18) aged 86. Mr. Hannay studied chemistry, metallurgy and other subjects at the Glasgow and Western Scotland Technical College and became Assistant Chemist in the laboratory of the Cassel Gold Co. in 1892. Subsequently he entered the textile industry and in 1906 went to Manchester as Chief Chemist in the C.P.A. Afterwards followed appointments at Know Mill Printing Co. and J. F. and E. Caulfield (1926-1934) as Works Manager. Mr. Hannay acted on Education and Advisory Committees and was a part-time Lecturer at the Manchester College of Technology from 1934 until 1937 when he took up an appointment at Liberty & Co.'s Merton Abbey works. When he retired in 1941 he was Assistant to the General Manager In 1915/16 he was awarded the gold research medal of the Worshipful Company of Dyers.

Dr. Paul Haas, who was an early member of the B.A.C. (1918/19) and acted for a number of years as one of the Trustees of the B.A.C. He was educated at University College School, University College, London and also in Geneva and Frieberg. Dr. Haas held appointment as Fellow of and Reader in Plant Chemistry at University College, Lecturer on Physics and Chemistry at Royal Gardens, Kew, Lecturer on Chemistry at St. Mary's and St. Thomas's Hospitals Medical Schools. He was author of 'Laboratory Notes on Organic Chemistry for Medical Students', and (with T. G. Hill) 'An Introduction to the Chemistry of Plant Products'.

News from the London Section

The Annual Meeting of the London Section was held at the Station Hotel, Barking on April 27.

The following officers and committee were elected for 1960/61:

Chairman: Mr. G. Robertson.
Vice-Chairman: Miss M. F. Locke
Hon. Treasurer: Mr. H. Morris.
Hon. Secretaries: Mr. E. H. G. Sargent, Dr. C. W. Capp.
Section Councillors: Area No. 1: Mr. V. J. Potter, Mr. R. E. Love. Area No. 2: Mr. G. H. Clarke, Mr. W. A. Phillips.
Committee: Mr. T. Bewley, Mr. P. A. Farmer, Dr. A. T. Healey, Mr. P. Horridge, Mr. F. Jowett.

Owing to the widespread nature of the London Section the Meeting was held on the east side of London this year for the convenience of members resident in Essex, etc. The usual supper was held after the business of the meeting had been concluded and was well attended.

LABORATORY EQUIPMENT & APPLIANCES

Laboratory Centrifuges

A revolutionary design in laboratory centrifuges has been manufactured by Martin Christ. Named the Junior 15,000, the centrifuge has a speed of 15,000 r.p.m., a capacity of 150 ml., and produces virtually no noise or vibration. The temperature change, even after long runs, is never more than 4° above the ambient temperature. This is achieved without any external cooling.

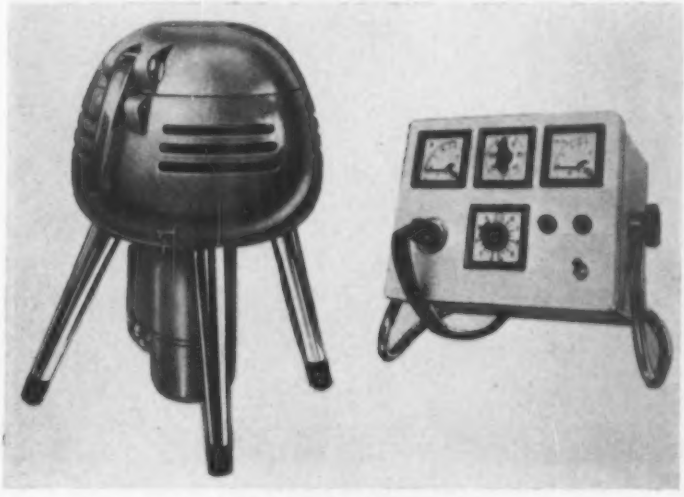
The special feature is that it can be used as a high speed centrifuge in a refrigerator or freezing chest. The control unit can be left outside the refrigerator for convenience and operation as the ribbon type connection cable is thin enough to fit between the resilient door packing and the door. Two rotors can be fitted to the centrifuge, the first 6 × 25 ml. in angle position and also 12 × 10 ml. in angle position. The rotor is elastically mounted and makes taring of the fillings unnecessary.

Another feature of this model is the easy manipulation of the cover which is also safety proof.

The company also manufacture a vacuum centrifuge known as the Omega.

The drive unit of this instrument is constructed for speed ranges up to 100,000 r.p.m. This has been provided in anticipation of the fact that materials will soon be available to permit practicable use of gravitational forces, of sizes previously thought unobtainable. Rotors of this type can then be employed on this model at the speed of 100,000 r.p.m., without further alteration. The current model is usable up to speeds of 60,000 r.p.m. and is available with three rotors, 6 × 100 ml., 8 × 50 ml., and 12 × 10 ml.

Omega vacuum centrifuge.

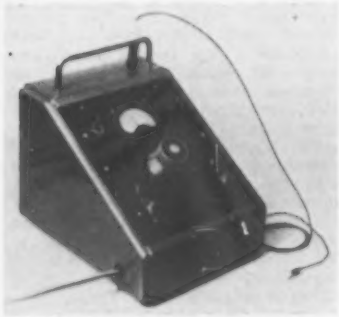


The Junior 15,000 centrifuge.

The remarkably smooth running of the machine needs to be stressed. If it were not for the instrument readings and control lamp, it would be almost impossible to tell visibly or audibly that the centrifuge is running. Neither the movement of the rotor, which incidentally can be kept under observation in the model fitted with armoured plexi-glass window, nor any noise can be clearly detected, despite the fact that a mass of several pounds' weight rotating at top speed, producing a force of gravity for making the substance weigh many hundreds of thousands of times its normal weight.

The temperature of the rotor is adjustable during operation over a range from —20°C. to +40°C. Accurate to within ±1°C. It is specified this range can be extended to between —80°C. and +150°C.

(U.K. Representatives: Hudes Merchandising Corporation Ltd., 52 Gloucester Place, London, W.1.)



A field plotter for schools and colleges.

Field Plotter Type FP.92

This new resistance analogue is really a two-dimensional version of the electrolytic tank. A special type of resistance paper is used and silver electrodes are painted on to it. By means of the field plotter the operator can draw the map of potential and flow lines with great convenience, and no particular skill.

The idea of using a resistive sheet is not new—it was first described by Kirchhoff in 1845, who used thin sheets of copper. The technique has been lying in abeyance, pending the discovery of a satisfactory material giving reasonable values of resistance and a more or less uniform resistivity. The sheet used in this instance is not perfect, but is certainly a great improvement. It has been used by various research workers for this purpose, since about 1950 but, so far as is known, until now there has been no commercial instrument available to exploit this novel technique.

This model sells at £33 and is therefore well within the reach of Sixth Forms and colleges in general.

(Manufacturers: Servomex Controls Ltd., Crowborough, Sussex.)

NEWS

Manufacturers' News

A New B.D.H. Subsidiary

A new company to be known as B.D.H. (Ireland) Ltd. is to be formed to undertake the manufacture and distribution of B.D.H. products in the Republic of Ireland. It is expected that the company will commence trading by the end of 1960. Mr. W. P. Mullen who has represented B.D.H. in Eire since 1943 will become Director and General Manager.

New Factory Layout for Q & Q

Following a two-year period of reorganization and mechanization costing £80,000, Quickfit & Quartz Ltd. have completed a new factory layout and production system which show an improvement in output of up to 30 per cent over previous methods at their Stone (Staffs) plant.

The development department is concerned with production methods and with the design of new laboratory apparatus. Here also, research is carried out into new methods, commencing with pilot-scale plant, before transition to full-scale production. The section is also engaged on research into the physical properties of glass.

The design section is responsible for liaison with customers over technical enquiries involving production of special equipment. Attached to the design section is the drawing office, where work ranges from the design of special laboratory apparatus to design of machine tools for construction in the company's machine shop. With the drawing office rests responsibility for issue and maintenance of the high standards set for the company's products

The raw material consisting of glass tubes is converted into various forms by manipulation in oxy-coal gas flames.

After this process components are fed on conveyor belts to an inspection unit, where each is inspected before receiving the ceramic transfer carrying the Q & Q insignia. This section is organized to process from 10,000 to 12,000 items per day.

After inspection and stamping, the ware is fed into a continuous annealing lehr, wherein it is heated to the appropriate temperature and cooled slowly to remove stresses introduced into the glass during flame-working. From this lehr the work is carried on a conveyor belt to a transit store for assembly into batches of suitable quantity and issue to the joint-grinding section.

In this section is a battery of five semi-automatic joint-grinding machines—designed and built by Quickfit & Quartz—each grinding six joints simultaneously. The production unit of five machines is designed for mass grinding of long runs. For smaller runs there are individual hand-grinding benches. After grinding, the joints are inspected again at illuminated inspection panels, from where they are passed to the warehouse for issue, as required, to the lamp-working section.

The main department in the lamp-working section consists of production lines of glass-blowers, plus positions containing rigs for mechanical assistance of hand blowing. These are lathes for holding, location, rotation and joining.

Adjacent to this section are the glass-tap section, and the laboratory apparatus and assembly section,

From the various departments mentioned above the finished product goes to the packaging department where the company have recently introduced a number of improvements in quality and appearance of wrap. Goods are packed in boxes in the distinctive Q & Q blue, and are stamped with the international wine-glass symbol. They are then sent from the packing department to the despatch department for despatch to customers all over the world.

DAG Exhibits at Acton

D. A. Gunn (Engineering) Ltd. showed two new developments at the Exhibition organized by the Acton Chamber of Commerce on April 20. One was a vacuum oven with a fibreglass body and the other was the barrel and vessel emptying pump. The latter has a fluid transfer performance of 5 gal. in 2½ min. at 6 ft. head—100 gal. per hour, with normal flow discharge as high as 120 g.p.h. There is also an attachment for circulating liquids, making it a versatile piece of equipment.

Exports to China

During the year ended March 31, 1960, Southern Instruments Ltd. have supplied ten of their K1,000 cathode ray polarographs to a value of £8,000 to the People's Republic of China. The total number of these instruments now in use in China is 13.

Personal Notes

Twyford Laboratory Appointments

The Director of Twyford Laboratories, Dr. H. D. Kay, C.B.E., F.R.S., announces that the following appointments have been made to his staff:

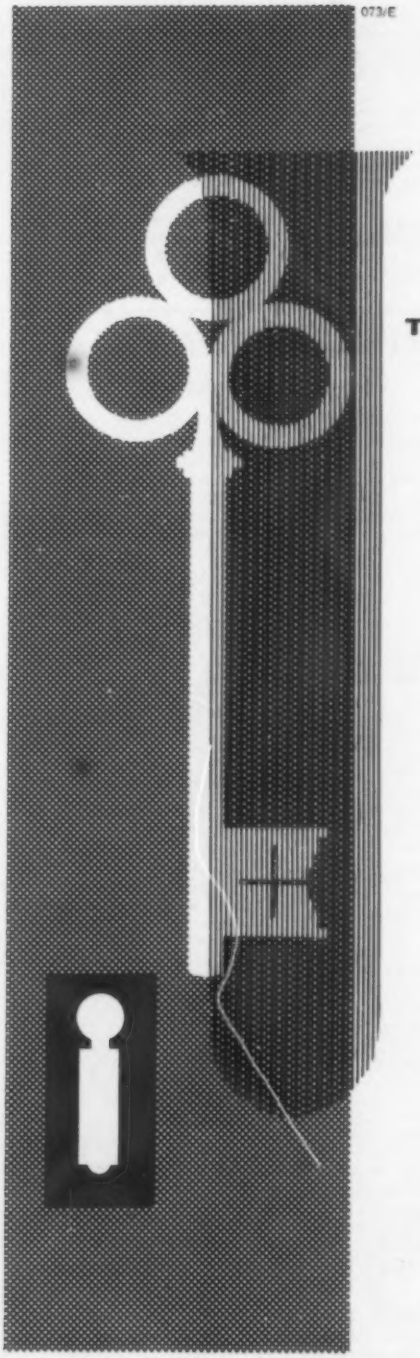
Microbiology Section:

C. Elizabeth Work, Newnham College, Cambridge, and formerly Research Student of that College, B.A.(Cantab.), Ph.D., D.Sc.(Lond.); assisted by V. A. Knivett, Fitzwilliam House, B.A.(Cantab.) Ph.D., A.R.I.C.

Since leaving Cambridge, Dr. Work has carried out research at the Lister Institute of Preventive Medicine; with I.C.I. (Plastics) Ltd.; in the Department of Chemical Pathology, University College Hospital Medical School, London; as Visiting Scientist at the National Institute of Health, Bethesda, U.S.A.; and, recently, at the Pasteur Institute, Paris.

Dr. Knivett's research work has been in the M.R.C. Unit for Chemical Microbiology at Cambridge; Department of Biochemistry, University of

An operator manipulating glass tubing on a typical joint forming machine at the Quickfit & Quartz factory, Stone.



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Sheffield; Research Fellow at the Dept. of Physiological Chemistry, University of Wisconsin, U.S.A.; Microbiology Section of the National Chemical Laboratory (Dept. of Scientific and Industrial Research), Teddington.

Biochemistry Section:

J. Leggett Bailey, Imperial College, London, B.Sc., A.R.C.S., Ph.D.(Lond.), Ph.D.(Cantab.), F.R.I.C., assisted by R. J. Sturgeon, University of Edinburgh, Ph.D.(Edin.).

Dr. Bailey's research experience has been at the Imperial College, London; the Department of Biochemistry, Cambridge; as Fellow of the Rockefeller Institute for Medical Research, New York; and, recently, at the Rowett Research Institute, Aberdeen. He has also had some experience of industrial research.

Dr. Sturgeon has carried out post-graduate research in Edinburgh University, and, recently, with the Distillers' Company, Ltd., Research and Development Department, Epsom.

Mr. J. E. Hornsby

Mr. J. E. Hornsby of 26 Perimeade Road, Perivale, Middlesex, has been appointed U.K. representative for the Ealing Corporation, Cambridge, Massachusetts. The Corporation are in close touch with the U.S. educational market and already represent in America a number of well-known British scientific instrument manufacturers. Mr. Hornsby would be pleased to hear from any companies who are interested in bringing their products to the notice of U.S. high schools, universities and hospitals. B.Sc., as quality control engineer at their

Mr. H. McGlyn

West Instrument Ltd. have announced the appointment of Mr. H. McGlyn, Brighton factory.

Mr. McGlyn, who is well known for his contributions to industry in the instrument field, is the representative of the Engineering Equipment Users' Association on the British Standards Institute Committee for the graduation of instruments.

During the war he was engaged in special duties at the Ministry of Supply, and was later seconded to Woolwich Arsenal for service on a permanent Electrical Engineering Standards Committee.

Since the end of the war he has been with Imperial Chemical Industries Ltd., first as engineer in charge of electrical and instrument standards, and secretary of the company's Instrument Standardization Committee, and later as instrument design engineer at the Metals Division Headquarters at Birmingham. Here he worked on a titanium plant and on the initial layout of a beryllium project.

More recently, he has been at the Central Instrument Laboratory at Pangbourne, where he was concerned with the development of special equipment for experiments in automatic control. Immediately prior to his new appointment, he was in charge of a department concerned with the evaluation of instruments.

Mr. H. McGlyn.

CATALOGUES, BROCHURES & LEAFLETS

Received from Manufacturers

Scientific News.—No. 3 in the Series 'Scientific' News, issued by Scientific Supplies Co., Ltd., of Vine Hill, London, E.C.1, introduces the improved S.S. range of retort stands, rings and burners; a newly designed bench blowpipe; a newly designed hydrolysing bath; a new constant level device, and details of new quantity discounts for non-proprietary items.

Chemicals and Reagents.—A very well produced catalogue and price list of chemicals and reagents for research and analysis and other technical purposes has been published by Hopkin & Williams Ltd., of Freshwater Road, Chadwell Heath, Essex. This is divided into five parts: organic and inorganic chemicals for research, analysis and other technical purposes; reagent solutions; microscopical stains and reagents; silicones; British chemical standards and Analoid preparations.

New Catalogues.—Negretti & Zambra Ltd., 122 Regent Street, London, W.1, have recently issued three new publications. These are: R/30/2E dealing with electric switch and contact automatic controllers and alarm mechanisms; A/19 Integrating indicator (Type I.R.) for use with N. & Z. aircraft fuel flowmeter; and F25/S. Spanish version of their general catalogue—this is the sixteenth version of the company's overseas catalogue.

Modern Laboratory Appliances.—A wide range of clamps for laboratory use, bunsen burners, micro burners, support and extension rings, tripods, retort stands, Uniframe laboratory scaffolding and combined burner and beater blocks (semi-micro) are described in a selection of leaflets issued by R. & L. Enterprises Ltd., Grangefield Road, Stanningley, Leeds.

Chemical Catalogue—A data sheet is available from Robinson Brothers Ltd., of Ryders Green, West Bromwich, on 1·4-di(carboxymethylthio) butane and 2·2′-di(carboxymethylthio) diethyl. These materials are available in experimental quantities and their suggested use is as metal deactivators or sequestering agents in those cases where ethylene diamine tetra-acetic acid or its homologues are ineffective, especially in acid or non-aqueous media.

Heat Treatment Journal.—The March 1960 issue of The Wild Barfield Heat-Treatment Journal published by Wild-Barfield Electric Furnaces Ltd., of Elecfurn Works, Otterspool Way, Watford By-Pass, Watford, Herts., and associated companies, contains a description of the company's exhibits at the International Machine Tool Exhibition and articles on a crystal pulling furnace and the automatic hardening and tempering of carbine barrel forgings.

Scientific Instruments.—W. G. Pye & Co., Ltd., of Granta Works, Cambridge, have just issued Catalogue N which gives full details of electronic instruments; galvanometer, indicating meters and accessories; general physics; magnetic instruments; measuring microscopes, cathetometers and accessories; potentiometers and accessories; chemical instruments and accessories; resistance bridges and boxes; and switches, clocks, etc.

'*Radioactive Chemicals*'.—This catalogue deals with the primary isotopes and labelled compounds which are of interest to all who use radioactive tracer methods and with radioactive pharmaceuticals. It includes radioactive reference sources for calibrating instruments.

'*Radioactive Sources*'.—This catalogue deals with sealed radioactive sources and appliances which will be of interest to radiotherapists and to industrial users of ionizing radiations. It also includes a great variety of radioactive sources which can be used for research purposes.

Both these catalogues are available on request from the Radiochemical Centre, Amersham, Bucks.

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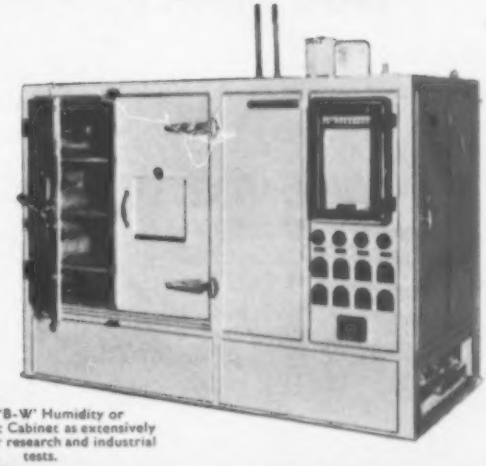

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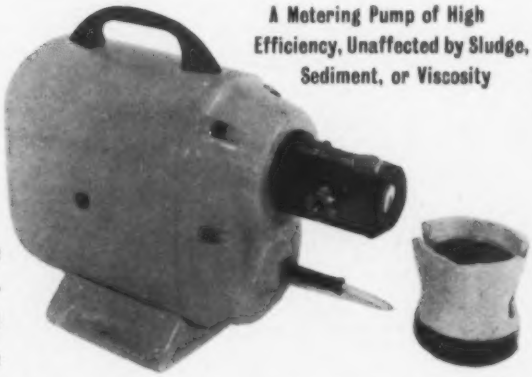

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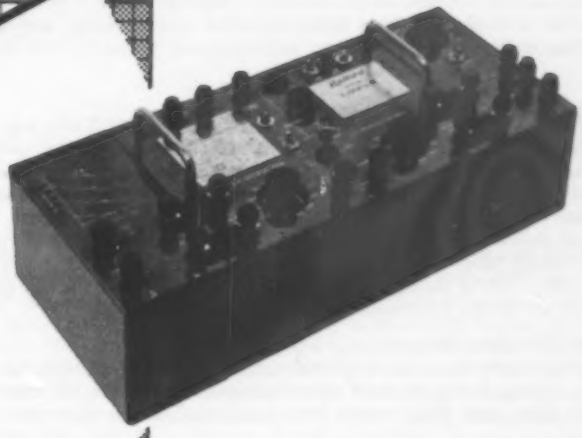

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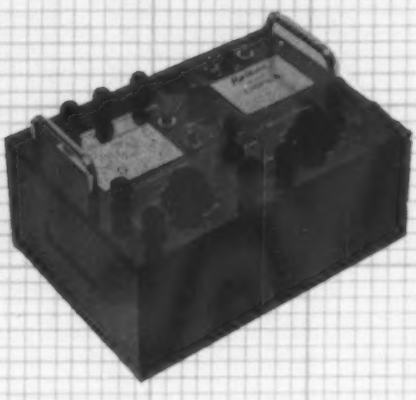


THE RADFORD UNIVERSAL LABPACK is a general purpose instrument for supplying a wide range of voltages suitable for experimental and demonstration purposes in science laboratories. It is essentially a transformer having a number of windings. One of the secondary windings is multi-tapped in 0.2V. stages up to 2.0V., and also 2.0V. stages up to 20.0V. These outputs are selected by means of two rotary switches, giving the required voltage at the AC output terminals. This AC voltage is also connected to a full wave selenium bridge rectifier producing a DC output to another pair of terminals. In addition there are voltages of 6.3V. 1 amp. for valve heaters and an HT winding of 250V. which is connected to a half wave contact cooled selenium rectifier giving an output of 250/200V. DC at 30/50mA. This apparatus is mounted on a strong aluminium panel together with the necessary fuses, switches, indicators etc. and housed in a stove enamelled steel case with ventilating louvres.

CURRENT AND VOLTAGE OUTPUT.

Variable LT. DC and AC.

The unit is designed to give approximately 6 amps. output at any voltage up to 22.0V., AC. or DC. If it is required to use the DC. and AC. output terminals simultaneously, then the combined currents should not exceed 6 amps. The low voltage output is controlled by two 12 way switches. One switch controls the output in 0.2V. steps and the other switch gives a coarser control in 2.0V. stages, the outputs being additive: i.e. in order to obtain an output of, say 17.6V., the fine control should be set to 1.6V. and the coarse control to 16.0V. These voltages are nominal ones and represent the voltage output of the transformer at approximately 0.7 of the maximum current rating.

High Tension Output.

The high tension is approximately 250/200V. at 30/50 mA. and is intended for valve experiments. The 6.3V. 1 amp. being used for valve heater supply. The H.T. output can, of course, be used for any purpose other than valve experiments where such a supply is required.

REGULATION.

By using grain oriented core material in the transformer and also low resistance windings, the inherent regulation characteristic of this equipment is extremely good, as will be seen in Figs 1 & 2.

FUSING.

The instrument is fused to prevent damage to the Labpack through severe mis-use; it is capable, however, of sustaining considerable overloads without suffering damage. The output fuses may be lower than the recommended maximum in order to protect delicate external equipment.

FIG. 1.

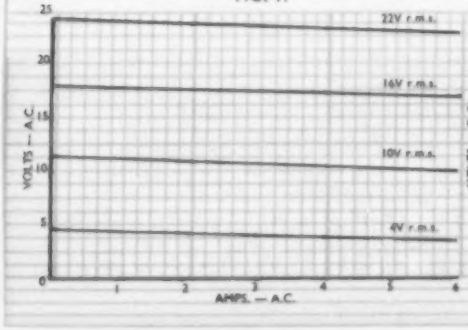
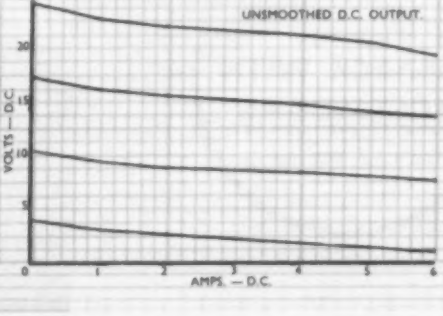
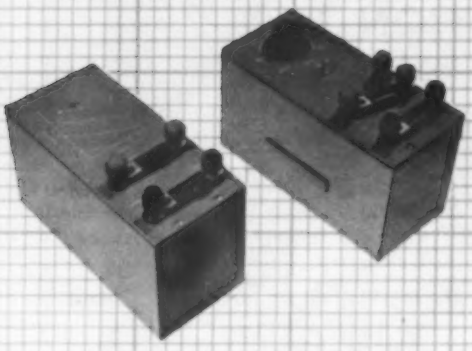


FIG. 2.



FIG

D.C. Amps.	% RIPPLE LT ATTACHMENT
0	0.02
1	0.15
2	0.34
3	0.53
4	0.82
5	1.25
6	2.5



SAFETY IN USE

An earth screen is fitted between the primary and secondary windings of the mains transformer and great care has been taken with earthing arrangements to provide absolute safety in use. A device is fitted which immediately tells the operator if the mains wiring is incorrect in respect of phase and neutral.

ACCESSORIES.

Ancillary units are also available, as illustrated, for increasing the smoothing on the high tension and variable LT. circuits as detailed below.

L.T. Smoothing Unit.

The L.T. Smoothing Unit comprises a choke and two 2,000μF capacitors which reduce the ripple voltage to approximately 0.5% at 3 amperes load. The chart illustrated (Fig. 5) shows the ripple values at other currents. The voltage-current regulation characteristic of the main unit, with the smoothing unit connected, is shown in Fig. 3 and is also printed on the front panel of the unit itself.

H.T. Smoothing Unit.

In addition to a choke and smoothing capacitors, the H.T. unit contains a voltage regulator valve VR 150/30. This valve maintains the output voltage constant at 150V., for variations of current from 0-30 mA. as indicated in Fig. 4. A variable potentiometer can be switched for use as either a rheostat or potentiometer. When used as a potentiometer, it is switched across the full output and the slider is connected to the variable output. Providing a small current only is drawn, the engraving on the voltage control shows a fairly accurate division of the output available from 0-150V. This facility is very useful for varying the screen voltage in valve experiments. When used as a rheostat a current of up to 30 mA. may be drawn. The approximate resistance of the rheostat in circuit is shown on an inverse scale on the voltage control. The ripple voltage content of the output of the H.T. Smoothing unit is less than 0.003% at 30 mA. current. See (Fig. 5)

BATTERY CHARGING.

In addition to the obvious uses in electrical, optical, chemical and electronic experiments, the Radford Labpack may be used as a battery charger for currents up to 6 amps at up to 12 or more volts. The Radford Labpack is therefore a complementary piece of equipment to batteries where they are still used for laboratory experiments.

IG. 5.

	I.D.C. M/Amps.	% RIPPLE H.T. ATTACHMENT
	0	0.002
	10	0.002
	20	0.002
	30	0.002
	40	0.035
	50	0.035

FIG. 3.

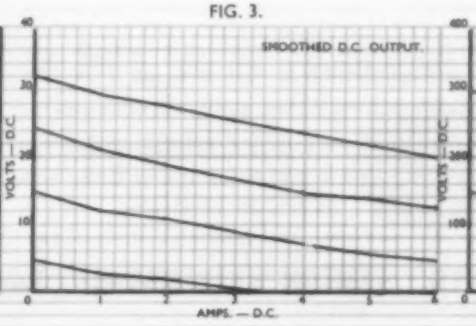
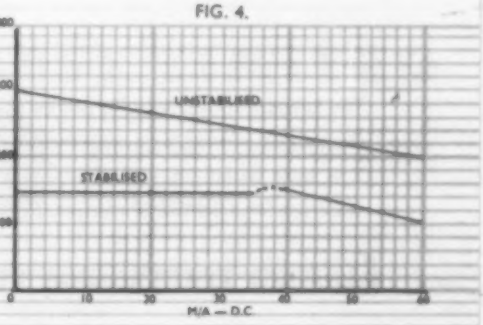


FIG. 4.



SPECIFICATION

MAIN UNIT

Input: 200—250 V. 50 c/s.

Outputs:

(1) L.T. A.C. 0—25 V. at 6 amps. max.

(2) L.T. D.C. 0—22 V. 6 amps. max.

(AC. and D.C. output continuously variable in 0.2 V. stages.
D.C. is rectified A.C. from selenium rectifier full wave bridge connected).

(3) H.T. D.C. 200—250 V. 50/30 mA for valve experiments.
(Rectified A.C. from half wave selenium rectifier and reservoir capacitor).
Ripple 10% at 50 c/s 30 mA load.

(4) L.T. A.C. 6.3 V. 1 amp. for valve heaters.

Size: 11½" x 8½" x 6" high overall.

Weight: 11 lbs. approx.

PRICE: 17 gns.

ACCESSORIES

H.T. Smoothing Unit

Outputs: D.C.

(1) 150 V. 0—30 mA Stabilised.

(2) 0—150 V. linear variable by potentiometer for voltage, or rheostat for current.

(3) 200—250 V. at 50/30 mA (Direct from main unit).

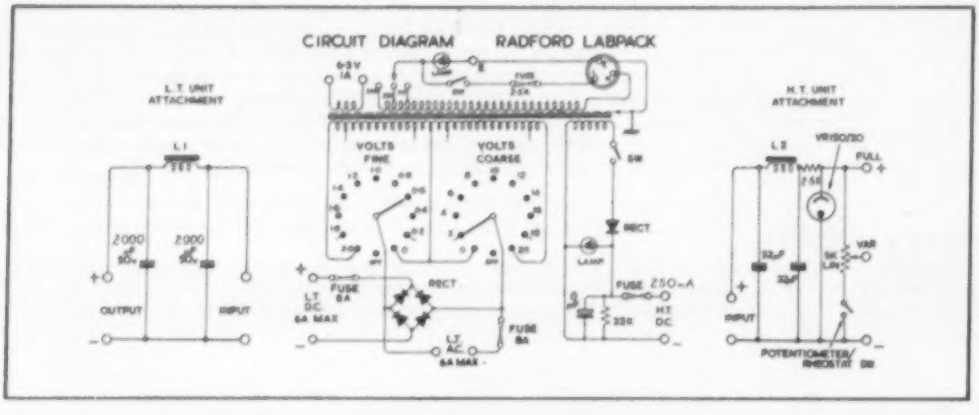
Ripple: Smoothed to less than 0.003% at 30 mA (50 c/s ripple).

PRICE: 7 gns.

L.T: Smoothing Unit

Variable L.T. from main unit smoothed to 0.5% at 3 amps. (100 c/s ripple).

PRICE: 6 gns.



GUARANTEE

The Labpack and accessories are extremely well made from quality materials and components, and should give service for a considerable number of years without attention or maintenance providing it is used within its capabilities. The equipment is guaranteed against faulty workmanship and materials for a period of one year.

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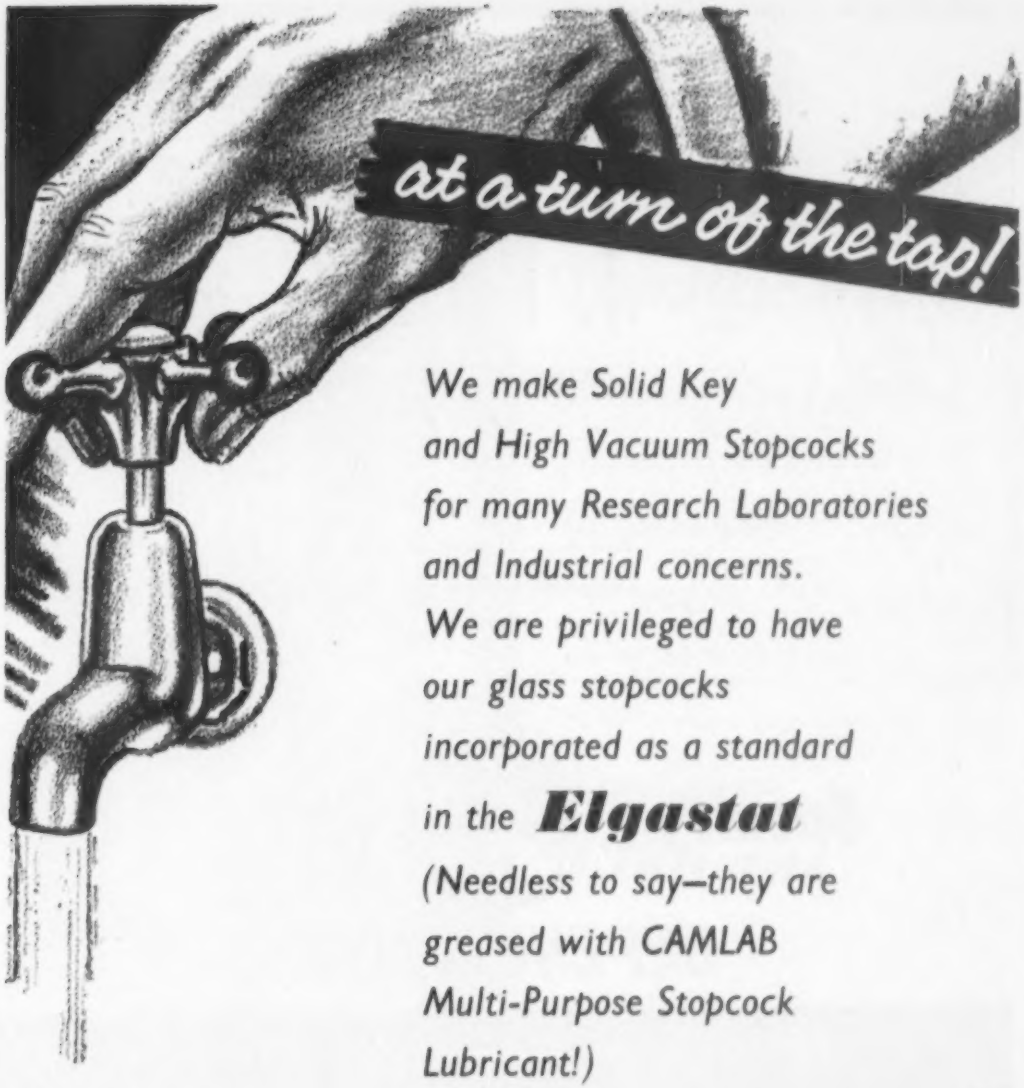

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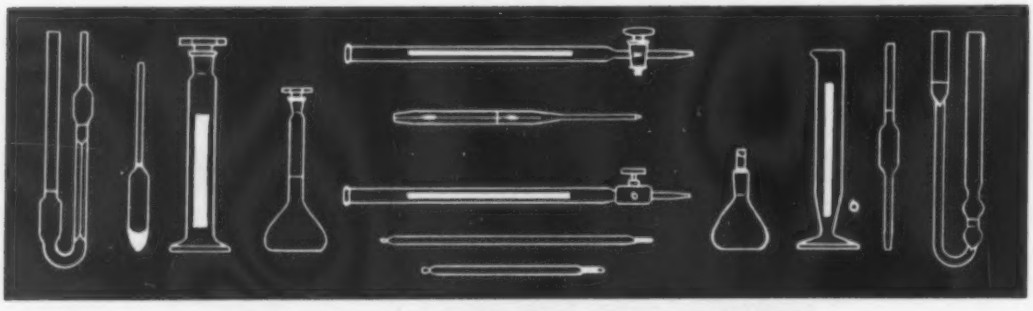

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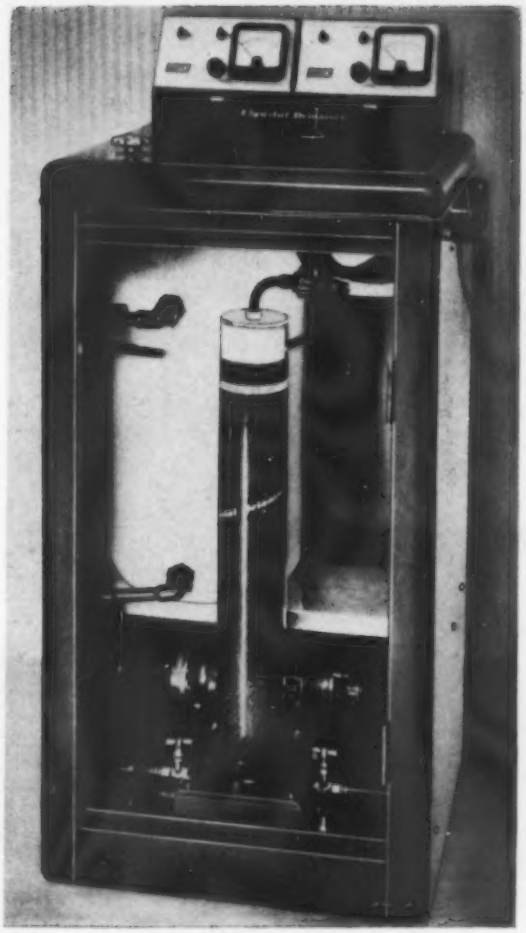

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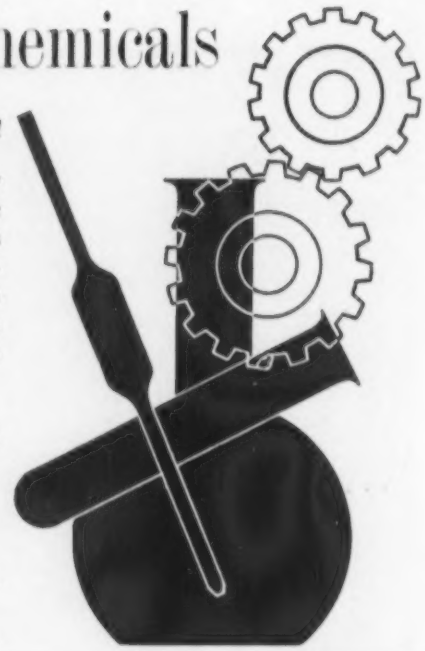

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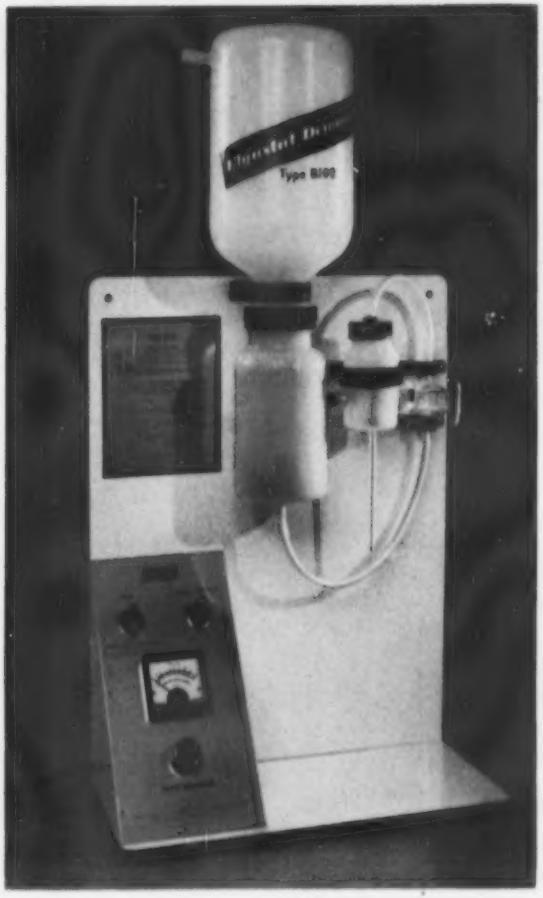

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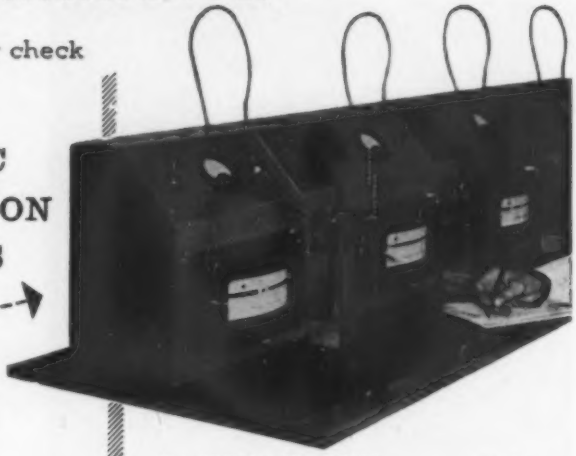

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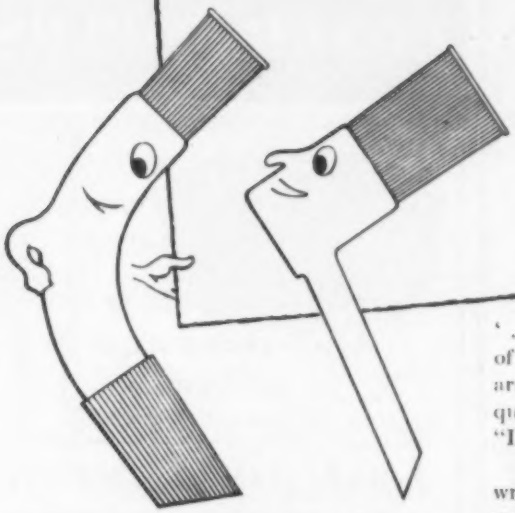

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'And the cartridge . . . ?'

'Oh! That goes back to Loughborough, but since it has "distilled" water fed to it, you only need to do this every 1,000 gallons or so.'

'*300-2,000 gallons, eh?* I'm going to find out more about this.'

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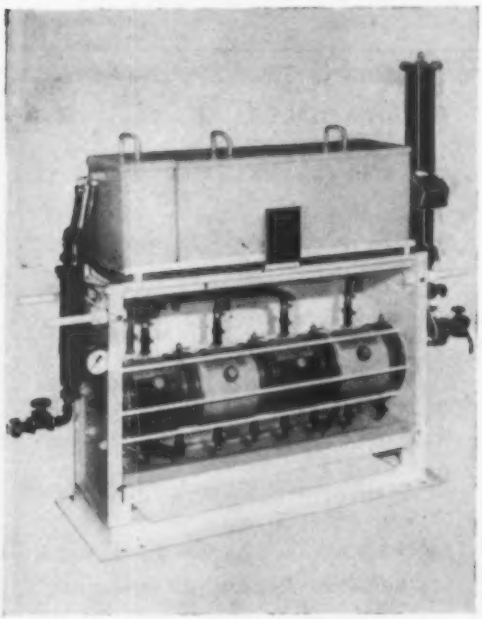

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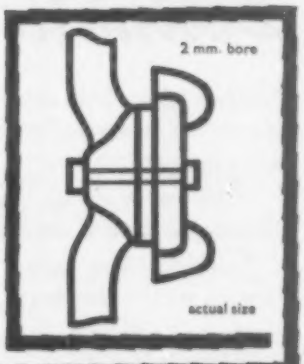

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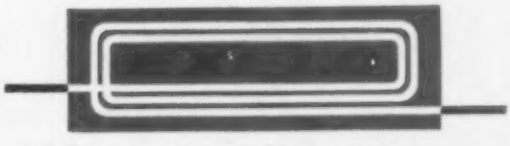

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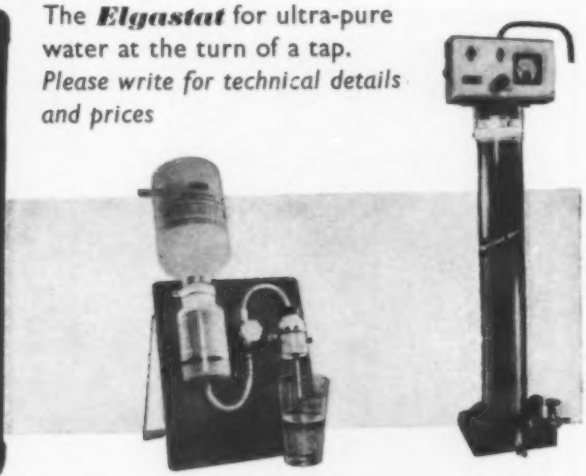

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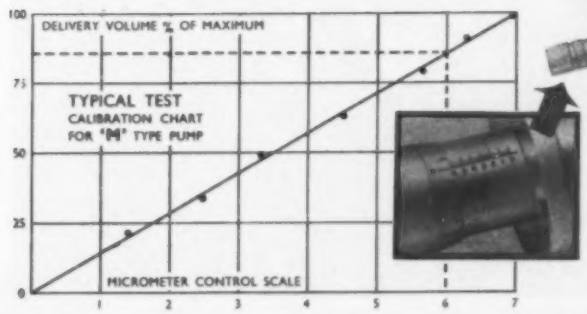

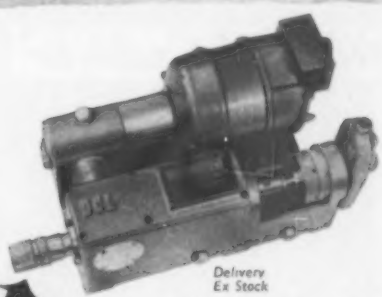

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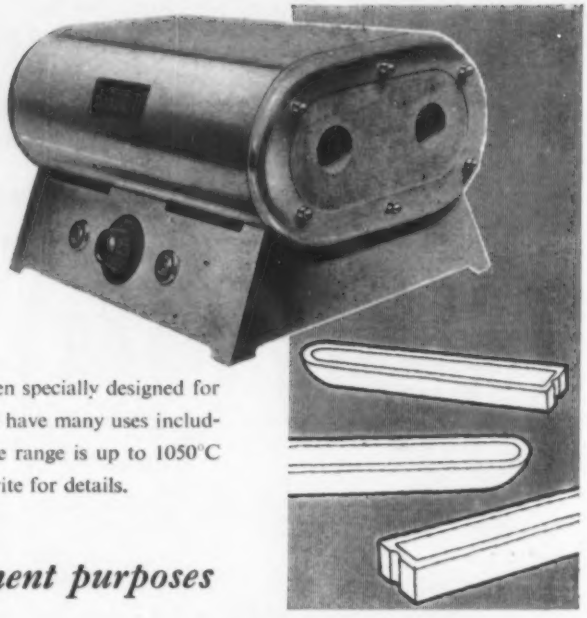

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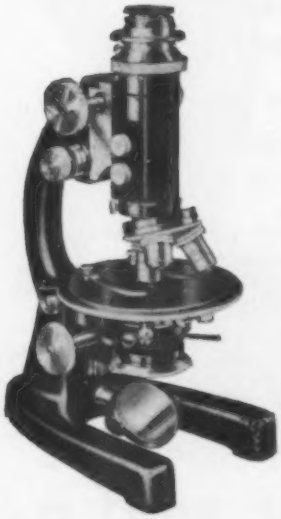

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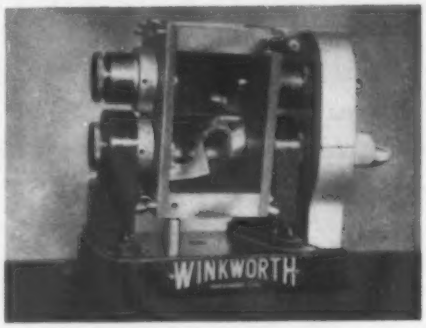

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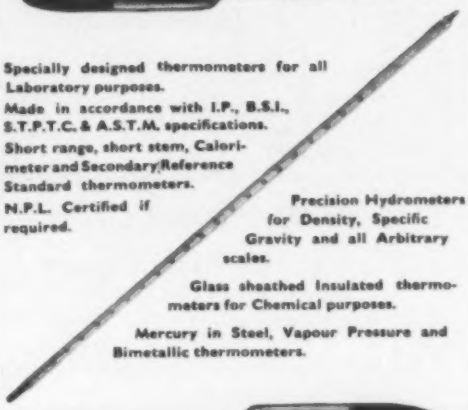

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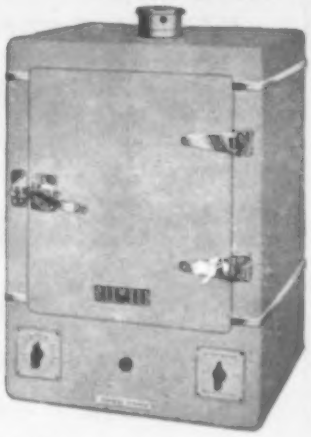

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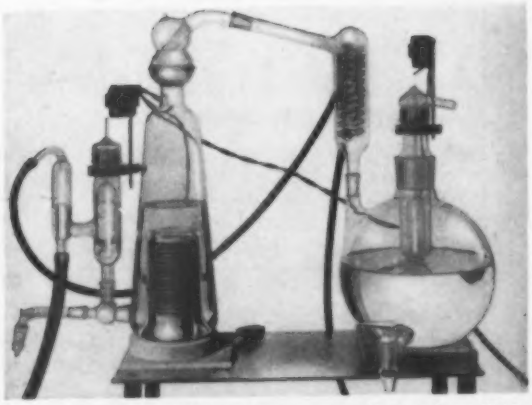

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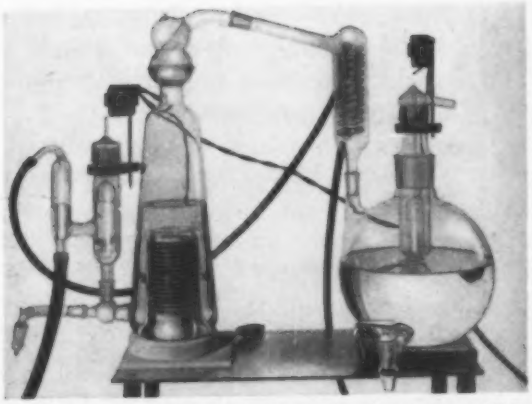

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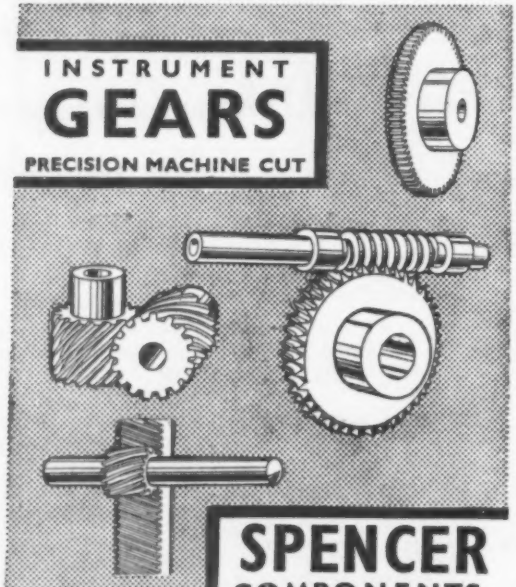

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